EXHIBIT 23

Rebuttal Report of Caroline M. Hoxby, Ph.D., dated April 6, 2018

IN THE UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF
NORTH CAROLINA

STUDENTS FOR FAIR ADMISSIONS, INC., Plaintiff,	Case 1:14-cv-00954-LCB-JLW
v.	
UNIVERSITY OF NORTH CAROLINA, et al., Defendants.	

REBUTTAL REPORT OF CAROLINE M. HOXBY, PH.D.

April 6, 2018

CONTAINS CONFIDENTIAL INFORMATION SUBJECT TO PROTECTIVE ORDER

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I. Introduction

1. I am Caroline M. Hoxby and I am the Scott and Donya Bommer Professor in Economics at Stanford University. On January 12, 2018 I submitted an expert report (my "opening report" or the "Hoxby Report") in this matter. My qualifications are described in detail in my opening report and appendices thereto.

2. I have reviewed reports by Prof. Peter Arcidiacono ("Arcidiacono Report") and Mr. Richard Kahlenberg ("Kahlenberg Report") submitted on January 17, 2018 and January 12, 2018, respectively, in support of Plaintiffs in this matter and have been asked to consider the opinions therein.[1]

3. In particular, I have been asked to assess Prof. Arcidiacono's attempted modeling of admissions at the University of North Carolina at Chapel Hill ("UNC"), and his opinion that race is a dominant factor in those admissions.[2] In addition, I have been asked to assess the simulations presented by Mr. Kahlenberg (which were actually performed by Prof. Arcidiacono), and his opinion that they show workable race-neutral alternative admissions plans.

4. I have been assisted in this matter by staff of Cornerstone Research, who worked under my direction, and I have relied upon the materials listed in Appendix A. I am being compensated at a rate of $637.50 per hour. My compensation is not contingent in any manner upon the nature of my findings or on the outcome of this litigation.

II. Summary of Opinions

5. None of the analysis or opinions presented in the Arcidiacono Report or Kahlenberg Report changes any of the opinions I presented in my opening report.

6. Even after reviewing the Arcidiacono and Kahlenberg Reports, it remains my opinion that race is not a dominant factor in UNC admissions. Similarly, I continue to opine that no workable race-blind alternative would allow UNC to maintain its racial diversity while also maintaining its current high academic standards.

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[1] Expert Report of Peter S. Arcidiacono, January 17, 2018 ("Arcidiacono Report"); Expert Report of Richard D. Kahlenberg, January 12, 2018 ("Kahlenberg Report"). I have also reviewed the rebuttal report of Professor Bridget T. Long, which addresses the opinions in the Kahlenberg Report.

[2] In this report, I use the terms "race" and "race/ethnicity" interchangeably to mean "race and ethnicity."

7. Prof. Arcidiacono's claims relating to UNC's admissions processes, including the role of race in that process, are unreliable and misleading. Rather than consider the role of race across the entire applicant pool, Prof. Arcidiacono instead focuses on smaller sets of non-representative applicants. The fact that race may be a factor for some applicants does not mean that race is a dominant factor in overall admissions decisions. In fact, consistent with the findings reported in my opening report, when I calculate the overall contribution of race/ethnicity to how well Prof. Arcidiacono's models explain admissions, I find that race/ethnicity explains only 2.0 percent to 6.7 percent, depending on the model. Thus, Prof. Arcidiacono's own models demonstrate that race is not a dominant factor in UNC's admissions. I have three main criticisms of his approach to assessing the question of whether race is a "predominant factor in UNC's admissions process:"[3]

i. First, Prof. Arcidiacono is wrong to suggest that a difference in average statistics across racial groups (e.g., that underrepresented minority ("URM") admits have lower SAT scores on average than non-URM admits) demonstrates that race is playing a significant or dominant role in the admissions process at UNC. A difference in average across any metric (whether test score, GPA, or other variable) does not, taken alone, establish anything about the role of race in the admissions process.

ii. Second, Prof. Arcidiacono's use of an "academic index" based on test score and GPA to purportedly illustrate the role of race in the admissions process is also misleading. Prof. Arcidiacono focuses on applicants who are not representative of those actually admitted to UNC and therefore the statistics he presents give a biased view of how race could affect the entire applicant pool. Even using Prof. Arcidiacono's own "academic index," an analysis of the applicants who are representative of UNC's admitted class shows that race is not a dominant factor in UNC's admissions process.

iii. Third, Prof. Arcidiacono attempts to demonstrate an alleged racial/ethnic preference in admissions by emphasizing how the predicted probability of admission for an Asian American (or white) applicant would change if he were a URM, such as

[3] Arcidiacono Report, p. 1. I interpret Prof. Arcidiacono's use of the word "predominant" as "dominant," which is the term that was used in the Complaint. *See Students for Fair Admissions, Inc. v. University of North Carolina*, Case No. 1:14-cv-954, The Middle District of North Carolina, dated November 17, 2014, ("Complaint,"), ¶¶ 4, 51, 199.

African American or Hispanic (I call these his "transformation examples"). But again, Professor Arcidiacono focuses on finding applicants who are not representative of the entire applicant pool. In other words, in his Tables 4.1 and 4.2, Prof. Arcidiacono presents a biased selection that fails to illustrate how such hypothetical changes to an applicant's race would affect *all* non-URM admits rather than the small, non-representative subset on whom he focuses. In addition, in these transformation examples, he does not account for UNC's "capacity constraints," which would considerably reduce the magnitudes he reports.

8. Prof. Arcidiacono also constructs models of the UNC admissions process. But these models do not effectively model UNC's holistic admissions process, and they are unreliable for the purpose of assessing UNC's admissions process and testing various proposed race-blind admissions processes. Simulations of these proposed race-blind admissions processes are contained in the Kahlenberg Report, but were apparently performed by Prof. Arcidiacono using his models. I refer to them as the "KA simulations." There are several reasons why Prof. Arcidiacono's models are unreliable:

i. First, by incorporating measures that can only be assessed through holistic, subjective review of an actual application file such as Personal Qualities or Essays (I discussed these "unverifiable measures" in my opening report) into the admissions model utilized in the KA simulations, Prof. Arcidiacono limits the population on which the model can be used. In other words, because of the way Prof. Arcidiacono chose to build his model, it can only be used with data from *actual* applicants to UNC. It cannot be used to model admissions for the broader set of *potential* applicants who might be incentivized to apply if UNC implemented a different admissions plan. This choice also means that Prof. Arcidiacono ignores the extensive data on this potential applicant pool that is available through data relating to all public school students in North Carolina—not just those who actually applied to UNC.[4] This is a severe

[4] These data are provided by the North Carolina Education Research Data Center (NCERDC) and I used them in my opening report. These data contain information on public school students in North Carolina and they include, among other things, information on the student's high school, the student's GPA, grades, class rank, graduation status, and standardized test scores. These data contain demographic information, such as the student's age, sex, and race/ethnicity. The data also contain information on whether the student qualified for a free or reduced-price lunch under the National School Lunch Program.

limitation because it means that alternative admissions plans cannot be evaluated adequately. Using a sample to fit a model that is not representative of the population over which prediction must be made is a very well-known problem in statistics and can result in highly biased predictions for evaluations of admissions plans. Because Prof. Arcidiacono's model is the foundation for the KA simulations of race-blind alternatives, the severe limitations of the model render the simulations and Mr. Kahlenberg's ultimate conclusions about race-blind alternatives unreliable.

ii. Second, Prof. Arcidiacono's admissions models are overfit. By this I mean that his models are constructed so that they *appear* to explain a good share of UNC admissions decisions but, in reality, his models work *only in the data used in the estimation of his models*. As soon as his models are used to try to predict which applicants would be admitted among some alternative sample of applicants or using data on hypothetical applicants (that is, any applicants outside the data used in estimation), his models cannot explain admissions decisions reliably. This is improper under well-established statistical principles.[5]

iii. Finally, Prof. Arcidiacono's admissions models suffer from various improper assumptions, and numerous errors, that further make them unreliable.

9. With respect to the analysis of race-blind alternatives set forth in the simulations contained in the Kahlenberg Report, I disagree that Mr. Kahlenberg has provided convincing evidence of a workable race-blind alternative that would allow UNC to maintain its racial diversity while also maintaining its high academic standards. In part this is because his findings are dependent upon Prof. Arcidiacono's flawed admissions models. I disagree with his opinions, however, for several other independent reasons:

i. First, the KA Simulations are unreliable in assessing what a hypothetical alternative admissions process would achieve because they are based entirely on past UNC applicants and do not account for the students who would apply under a newly implemented alternative admissions process. Experience from cases where race-blind

[5] For example, Prof. Arcidiacono does not use any of the established methods to test for, or correct for, problems that arise when using a selected sample (e.g., only UNC applicants) to draw inferences about a broader population.

admissions plans have actually been implemented, as well as the change in incentives to apply to UNC that would be created by Mr. Kahlenberg's dramatic changes to how UNC would evaluate applicants, imply that the applicant pool would change under the hypothetical alternative admissions plans that Mr. Kahlenberg analyzes. Using data on North Carolina public high school students (the majority of UNC applicants), I show that the results of his simulations are very different when applied to the pool of likely potential applicants to UNC. When applied to those students, Mr. Kahlenberg's simulations imply that UNC would admit a class that is much less academically qualified.

ii. Second, Mr. Kahlenberg proposes extremely large preferences for socioeconomically disadvantaged applicants. These preferences are so large as to, in many cases, swamp all other factors in a student's application and result in a large part of the admitted class being determined solely by socioeconomic status. For example, a student receiving Mr. Kahlenberg's "SES family" and "SES neighborhood" preferences (as in his Simulation 3), would be receiving a preference equivalent to over 550 SAT points in the admissions model upon which Mr. Kahlenberg relies.

iii. Third, numerous suggestions made by Mr. Kahlenberg regarding alternative admissions plans are unfounded, unworkable, or both. In particular, Mr. Kahlenberg proposes a highly idiosyncratic version of a "Percentage Plan" (or "Top X Percent" plan) that does not correspond to Top X Percent plans that have been actually implemented by other institutions or discussed in academic research and literature. His proposed plan is so unusual that, in my opinion, it is unworkable or, if implemented, it would not result in the admitted class that Mr. Kahlenberg presents in his Simulation 5. Other suggestions made by Mr. Kahlenberg, such as eliminating alumni preferences, utilizing wealth data, or enhancing recruiting, are unrealistic or he has not specified how they would actually be implemented.

iv. Fourth, Mr. Kahlenberg does not attempt to evaluate alternative admissions plans solely on the basis of whether they would allow UNC to maintain racial diversity. Instead, in each instance, his evaluation of a plan focuses equally on whether it increases UNC's socioeconomic diversity. This is not my understanding of what

UNC must consider when considering whether a workable race-blind alternative exists.

10. The rest of this report proceeds as follows. In Section III, I discuss Prof. Arcidiacono's results and opinions regarding the magnitude of race/ethnicity preferences in UNC's admissions process. In Section IV, I discuss Prof. Arcidiacono's modeling of UNC's admissions process more generally and the problems associated with using his models to evaluate hypothetical alternative admissions plans. In Section V, I discuss Mr. Kahlenberg's and Prof. Arcidiacono's "simulations" of alternative admissions plans and whether any of their results suggest that there is a workable race-blind alternative admissions plan that would allow UNC to achieve its diversity goals while maintaining the academic preparedness of its incoming class.

11. At the outset, I note that, in several places in this report, I provide results based on Prof. Arcidiacono's models of UNC's admissions process. Doing so should not be misconstrued as my acceptance that his models are accurate or reliable (in fact, in this report I discuss many reasons why his models are not reliable). I present these results merely to show in certain instances that, *even if one were to accept Prof. Arcidiacono's model, which I do not*, Prof. Arcidiacono's and Mr. Kahlenberg's conclusions are not warranted.

III. Contrary To Prof. Arcidiacono's Claims, Race is Not a Dominant Factor in UNC's Holistic Admissions Process

12. To begin, it is useful to discuss a fundamental difference in the way that Prof. Arcidiacono and I approach the question of assessing the role race plays in UNC's admissions process. This is particularly important given that we both attempt to model UNC's admissions using statistical regression models, and yet seemingly come to very different conclusions.

13. Prof. Arcidiacono approaches the question from a much narrower perspective: if, according to his model, race seems to play a role in the admissions decision, even for a small subset of applicants, it appears that he interprets race to be the "dominant" factor.[6] The reason I say Prof. Arcidiacono focuses on a small subset of applicants is that he chooses to present results in his Tables 4.1 and 4.2 (along with accompanying text) based on particular hypothetical

[6] *See*, e.g., Arcidiacono Report, pp. 43–45.

individual applicants who are not representative of UNC's admissions process or entire applicant pool. Moreover, even for these applicants, Prof. Arcidiacono has not shown that race/ethnicity is a dominant factor.

14. I consider the question from a broader perspective. As I understand the state of the law, race *can* permissibly play a role in an individual admissions decision – the proper question is whether race is a dominant factor in overall admissions decisions.[7] This is why, in my opening report, I analyze the extent to which race can explain admissions decisions *across the entire* applicant pool. In my opening report, I showed that race plays a small role overall in explaining actual admissions decisions at UNC, contributing not more than a 5.6 percent share to the admissions decision, across all applicants.[8] As an example of why one cannot focus solely on an individual applicant, there are likely some students for whom playing the oboe, or being good at debate, tips them from not-admit to admit – this does not mean that those are dominant factors in admissions.

15. In this section, I discuss the reasons why I disagree with Prof. Arcidiacono's opinion that race plays a dominant role in admissions. Although he claims to find that "significant" preferences are given to URM applicants, his report actually does not provide support for that conclusion.[9] Nor in fact, does his report show that race plays a significant role for any individual applicant.[10] First, the average statistics for admitted URM and non-URM applicants that he calculates are not probative in determining the importance of race in UNC's admissions process. Second, Prof. Arcidiacono's analysis of "academic index" deciles misleadingly fails to account for the fact that most of UNC's admitted students come from just a few of those deciles. Third, Prof. Arcidiacono provides misleading and non-representative hypothetical examples of the magnitude of the change in admissions probability from "transforming" an individual non-URM applicant into a URM applicant.

16. However, before turning to the discussion of each of these points, I first show that when one uses Prof. Arcidiacono's own model to estimate the contribution of race/ethnicity in

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[7] To suggest that race can *never* play a role in *any* admissions decision would seem to deny the possibility of considering race at all. I understand that the current state of the law allows for UNC to consider race as part of its admissions decisions.
[8] Expert Report of Caroline Hoxby, January 12, 2018 ("Hoxby Report"), Exhibit 1: Tables 1–2.
[9] Arcidiacono Report, p. 2.
[10] *See*, Sections III.C and III.D.

explaining admissions decisions *across the entire applicant pool* (as I did in my opening report), one finds that the contribution is small, consistent with the findings in my opening report.

A. Even Using Prof. Arcidiacono's Models, the Contribution of Race in Explaining Admissions Decisions on the Whole is Small, Consistent with the Findings in my Opening Report

17. In my opening report, I used well-accepted statistical approaches (including the R-squared and the Shapley decomposition of the R-squared) to assess which particular factors might drive the explanation of admissions decisions.[11] Through this analysis, I showed that race/ethnicity explains at most a small share of UNC's admissions decisions: approximately 0.8 percent to 5.6 percent, depending on the model.[12]

18. If one applies the same methodology to Prof. Arcidiacono's models, one finds similar results. **Exhibit 1: Table 1** shows the R-squared and the contribution of race/ethnicity in Prof. Arcidiacono's Models 2 through 7.[13] This table shows that the contribution of race/ethnicity in explaining admissions decisions is small: approximately 2.0 percent to 6.7 percent, depending on the model. Hence, when one examines the importance of race for admissions decisions overall, even Prof. Arcidiacono's models show that race contributes only a small amount to UNC admissions outcomes.[14]

19. In the following sections, I discuss Prof. Arcidiacono's conclusions and how they can lead to such apparently different conclusions than those reported in Exhibit 1.

B. The Average Characteristics of Admitted URM and Non-URM Students Are Not Probative in Answering the Question of Whether Race or Ethnicity Is a Dominant Factor in UNC's Admissions Process

20. To frame his conclusions, Prof. Arcidiacono provides statistics on the test scores, GPAs, ratings, and demographic characteristics of URM and non-URM students who apply to and are admitted by UNC.[15] He concludes that, among admitted students, non-URMs have higher test

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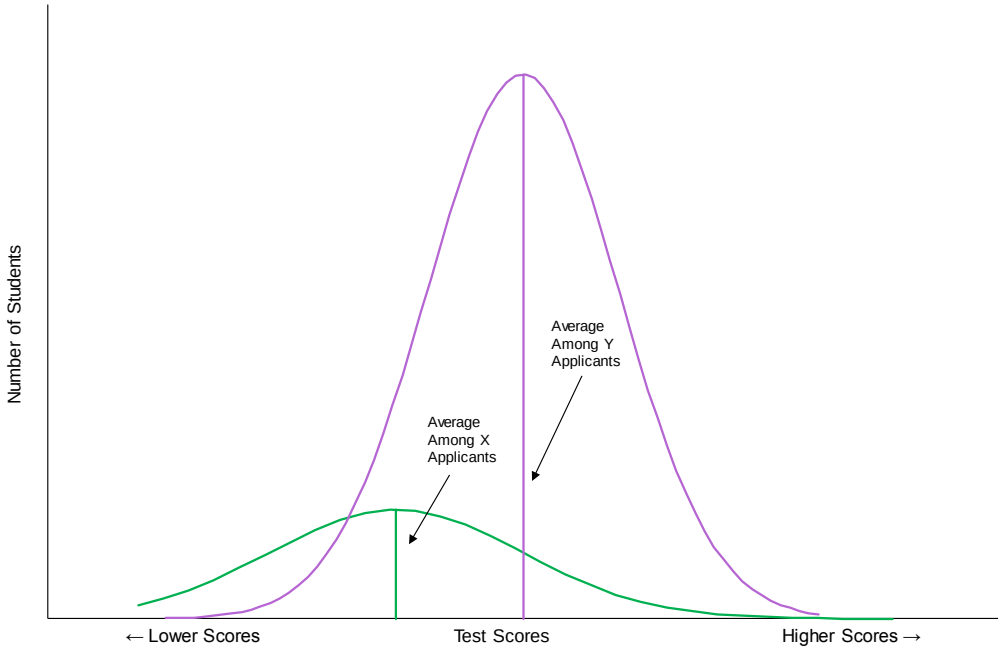
[11] Hoxby Report, ¶¶ 44–46.
[12] Hoxby Report, Exhibit 1: Tables 1 and 2.
[13] The Arcidiacono models are described in the Arcidiacono Report, Figure 4.1.
[14] Note that although I show results based on Prof. Arcidiacono's models in Exhibit 1 that does not imply that I consider Prof. Arcidiacono's models to be accurate or reliable.
[15] Arcidiacono Report, Tables 2.3 and 2.4.

scores, grades, and UNC ratings than URMs.[16] Plaintiff's Complaint itself suggests that comparisons of the average test scores, grades, academic index, etc., of URM students and non-URM students are probative regarding the role of race in admissions.[17] However, as I describe below, such comparisons do not shed any light on the extent to which race/ethnicity is a factor (much less a dominant factor) in admissions decisions.

21. It is easiest to see this by considering a hypothetical example. Suppose there are two groups of students (X and Y). Now consider **Exhibit 2: Figure 1a** and **1b**. Each figure shows the distributions of test scores for two hypothetical groups of students X and Y. The distribution for students in group X is green and the distribution for students in group Y is purple.

Exhibit 2: Figure 1a



22. Notice that there are fewer students in group X than in group Y. (That is why the X distribution is generally lower than the Y distribution in Exhibit 2: Figure 1a.) Notice as well

[16] Arcidiacono Report, pp. 25–26. The one exception, he states, is the Personal Quality rating.

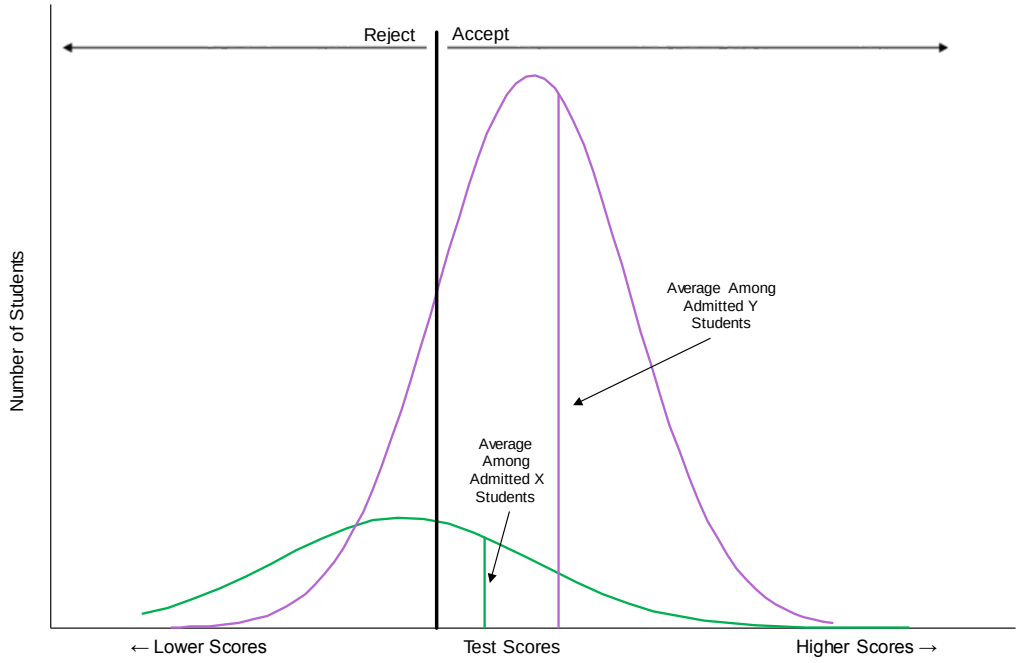
[17] See for example, Complaint Tables A and B. "These statistics show that UNC-Chapel Hill does not use race simply as a "plus" factor. For African American applicants with an academic index above 3.1, race is a dispositive factor essentially guaranteeing admission. For Asian-American applicants with an academic index below 2.6, on the other hand, race is a dispositive factor virtually guaranteeing rejection." Complaint, p. 54. "In particular, the statistics show a massive academic achievement gap between non-preferred admitted students and underrepresented minorities. The average high-school GPA and SAT scores for nonpreferred students (Asian American + white) are 4.57 and 1375. The average high school GPA and SAT scores for underrepresented minorities (African American + Hispanic + American Indian/Alaska Native) are 4.40 and 1269." Complaint, p. 56.

that the distribution of test scores among X students is shifted leftwards, compared to that of Y students. Thus, the average test scores of X students are lower than the average test scores of Y students.

23. Suppose that a university admits students in a manner that is blind to membership in group X or Y, purely on the basis of test scores. With such an admissions plan, the university would draw an admissions cut-off, as shown by the bold vertical black line in Exhibit 2: Figure 1b. Students to the right of the cut-off line are admitted, and students to the left of the line are rejected. Again, this test-score based admissions plan is completely blind to membership in group X or Y.

24. Now, if one were to compute the average test scores of students who were admitted via this process, the average scores of X students would be considerably lower than the average scores of Y students. These averages are shown as the vertical green and vertical purple colored lines in Exhibit 2: Figure 1b. These differences arose even though the university practiced admissions that were entirely blind to group membership. The differences in average scores in the two groups of admitted students is simply an artifact of the underlying distribution of scores in the two populations.

Exhibit 2: Figure 1b



25. As this simple example shows, comparisons of average qualifications among groups of admitted students are not probative of the dominance of race/ethnicity in admissions.[18] Differences can arise even when admissions are race-blind, or race is not a factor used in admissions at all, let alone a dominant factor.

26. The conclusion of this simple example also applies to holistic admissions. As in the above example, differences in average qualifications across admits in different racial or ethnic groups can arise due to differences in the underlying group populations and are not necessarily the effect of any use of race/ethnicity in admissions.

[18] In Section IV.C of the Hoxby Report, I explained that to "assess the magnitude of losses to the university's mission, it is reasonable to consider how the *average* statistics, such as the *average* test scores, of UNC's student body change under each alternative admissions plan." The exercise conducted in my original report is entirely conceptually distinct from the comparison of average test scores between groups of admitted students conducted by Prof. Arcidiacono. I use the differences in average test scores of admitted and matriculating students across different hypothetical admissions plans to assess potential losses to the university. Prof. Arcidiacono appears to be trying to draw inferences about the magnitude of racial preferences by comparing the average statistics *between* racial/ethnic groups.

C. Prof. Arcidiacono's Analysis of Race/Ethnicity by "Academic Index" Decile Is Misleading and Does Not Provide Evidence that Race/Ethnicity Is a Dominant Factor in Admissions

27. After presenting the differences in average characteristics of admitted URM and non-URM students, Prof. Arcidiacono conducts an analysis of admission rates by decile of an "academic index" of his construction.[19] (I refer to this as the "Arcidiacono Index" hereafter as it is an instrument used only by Prof. Arcidiacono.) This Arcidiacono Index is a weighted average of the applicant's SAT score and high school GPA.[20] UNC does not admit students based on such an index, nor do UNC's own policies or statements suggest that the University values only test scores and grades. To the contrary, as I discussed in my opening report, UNC's admissions policies articulate a broad range of criteria used in evaluating candidates, including with respect to key intangibles that go beyond only educational preparation.[21]

28. Once Prof. Arcidiacono has constructed his index, he groups applicants into 10 equal-sized groups or "deciles" based on the index. He then compares admissions rates for applicants of various races, within each Arcidiacono Index decile.[22] He concludes that "admission rates are substantially lower for non-URMs within each academic index decile."[23] This exercise—along with Prof. Arcidiacono's interpretation of its results—is flawed and misleading in two key ways:

i. The Arcidiacono Index—by construction—puts no weight whatsoever on such qualities as creativity, grit, leadership, motivation, social and cultural contributions, and so on that are part of the UNC admissions process. This matters because if the students in each decile of the Arcidiacono Index are not in fact assessed holistically to be equal applicants, then comparisons of their admissions rates tell us nothing about the role that race may play in their admissions decision. For instance, if non-URM students within each decile have subjectively assessed qualities than are inferior to

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[19] Arcidiacono Report, Section 3.
[20] Arcidiacono Report, p. 26.
[21] Hoxby Report, ¶ 13; UNC0079430; UNC0323603 (2016-17 Reading Document). Note that in my opening report I incorrectly cited the 2016-17 Reading document as UNC0000010.
[22] Arcidiacono Report, p. 27.
[23] Arcidiacono Report, p. 29.

those of URM students in the same decile, the non-URM students *should* presumably have lower admissions rates than the URM students.[24]

ii. Even if the admissions rates were made to be identical across racial/ethnic groups within each Arcidiacono Index decile (effectively removing the alleged preference that Prof. Arcidiacono claims UNC gives to URMs), the admissions outcomes would change very little due to UNC's status as a highly-selective institution and the fact that three-quarters of its admitted applicants come from the top deciles within the Arcidiacono Index. In fact, within each in-state decile and each out-of-state decile, setting the URM and non-URM admissions rates to be equal would never cause the number of non-URM admits to rise *by even 1 percent* relative to all admits.[25] This is shown in **Exhibit 2: Table 1** which is based on Prof. Arcidiacono's own calculations (presented in Tables 3.1 through 3.4 of his report). Considering all the in-state and out-of-state deciles together, and setting the URM and non-URM admissions rates to be equal would cause the number of non-URM admits to rise by only 7 percent of total admits.[26] Even if we were to assume that the Arcidiacono Index should be the sole basis for admission, his evidence still does not demonstrate that race/ethnicity is a dominant factor in admissions. This non-dominant effect takes Prof. Arcidiacono's own flawed index as given and employs his own calculations.

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[24] Consider comparisons between a URM applicant and non-URM applicant, both of whom have the same test scores and grades. If one were to find that, within this comparison, the URM applicant had more challenging childhood circumstances, then the URM applicant would tend to have a greater level of some factor that allowed him or her to overcome those more challenging circumstances. This is the case so long as one grants any role to challenges during childhood and adolescence in the determination of test scores and grades.

[25] These numbers are based on Prof. Arcidiacono's academic index, which does not accurately reflect UNC's admissions process or decisions. This statement does not say anything about what would happen under an *actual* race-blind admissions plan.

[26] Again, note that this number is based on Prof. Arcidiacono's academic index, which does not accurately reflect UNC's admissions process or decisions. This statement does not say anything about what would happen under an *actual* race-blind admissions plan.

Exhibit 2: Table 1[27]
Change in Non-URM Admits with Equalized Admissions Probabilities within Each Arcidiacono Academic Index Decile
Average Admissions Cycle (2011-12 to 2016-17)

	Change in non-URM In-State Admits [2]			Change in non-URM Out-of-State Admits [2]		
Decile Based on Arcidiacono Index	Change in non-URM Admits [3]	Change as a Share of In-State Admits [4]	Change as a Share of All Admits [5]	Change in non-URM Admits [3]	Change as a Share of Out-of-State Admits [4]	Change as a Share of All Admits [5]
1	1	0.02%	0.02%	0	-0.01%	0.00%
2	13	0.32%	0.24%	9	0.58%	0.15%
3	35	0.84%	0.62%	17	1.13%	0.30%
4	41	0.99%	0.73%	30	2.04%	0.54%
5	44	1.07%	0.79%	34	2.25%	0.60%
6	31	0.75%	0.55%	33	2.20%	0.58%
7	14	0.34%	0.25%	36	2.44%	0.64%
8	5	0.13%	0.10%	27	1.82%	0.48%
9	2	0.04%	0.03%	21	1.43%	0.38%
10	0	-0.01%	0.00%	19	1.28%	0.34%

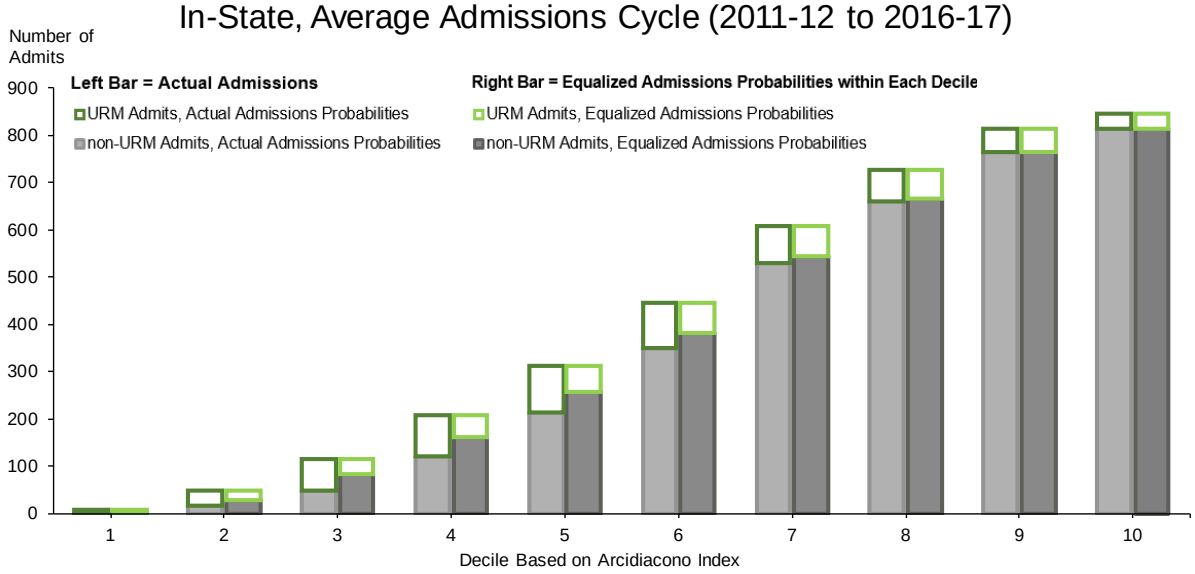
29. To understand why it is misleading for Prof. Arcidiacono to suggest that Tables 3.3 and 3.4 of his report show that race plays a dominant factor in UNC's admissions process, it is critical to consider the number of admits in each Arcidiacono Index decile—a fact that is not reflected in these two tables. This fact matters because, due to UNC's status as a highly-selective public institution, certain deciles generate hardly any admits of any race and the top deciles generate about three-quarters of all admitted applicants. Within these top deciles—which are the ones most relevant because they generate such a large percentage of the class—URM and non-URM applicants have similar admissions rates. This is shown in **Exhibit 2: Figures 2a** and **2b**.

30. Exhibit 2: Figure 2a shows in-state URM and non-URM admits by Arcidiacono Index decile for the average cohort, based on Prof. Arcidiacono's own statistics. The deciles are noted on the horizontal axis, and the number of admits is noted on the vertical axis. Within each decile, the column on the left shows UNC's actual admits, broken into URM (the top, lighter portion of the column) and non-URM (the solid bottom part of the column). The column on the right shows the number of URM and non-URM admits based on the Arcidiacono Index UNC would have if it were to set the admissions rate to be equal across URMs and non-URMs within the decile—in other words if UNC were to remove the alleged admissions "boost" that Prof.

[27] *See*, Exhibit 2 for sources and notes.

Arcidiacono suggests UNC is giving to URM applicants.[28] Note that equalizing the admissions rate across URMs and non-URMs does not change the number of admits in each decile, only the composition; the total height of each column remains unchanged.

Exhibit 2: Figure 2a[29]
UNC Admits by Decile Based on Arcidiacono Index
In-State, Average Admissions Cycle (2011-12 to 2016-17)



31. For instance, the columns at the far right of Exhibit 2: Figure 2a are applicants from the 10th or highest and most "qualified" decile, based on the Arcidiacono Index. In the average year, there are 816 non-URM admits and 32 URM admits from this decile. (This is the left-hand column within the 10th decile.) As Prof. Arcidiacono acknowledges, the admissions rates are very similar across non-URM applicants (98.7 percent) and URM applicants (97.9 percent) within this decile. Thus, if we were to set the admissions rate to be identical across non-URM and URM applicants within this decile, admits would hardly change at all. That is why the right-hand column within the 10th decile looks almost exactly the same as the left-hand column.

32. Again, what happens in the 10th decile matters because of UNC's status as a highly selective public flagship institution. In fact, approximately 75 percent of UNC's in-state admits come from the 7th, 8th, 9th, and 10th deciles in an average year. This can be seen in Exhibit 2: Figure 2a which shows high columns in those deciles. In all of these deciles, the admissions

[28] Note that this Exhibit is based on Prof. Arcidiacono's academic index, which does not accurately reflect UNC's admissions process or decisions. This statement does not say anything about what would happen under an *actual* race-blind admissions plan.
[29] *See*, Exhibit 2 for sources and notes.

rates for URM and non-URM students are similar so that admission outcomes would hardly change if the rates were equal across URM and non-URM students. To see this, compare the left-hand column to the right-hand column within each decile. Since (i) the role of race/ethnicity in these deciles (in-state deciles 7 through 10) is minor and (ii) these deciles account for about three-quarter of admits in an average year, the role of race/ethnicity is not a dominant factor for the majority of UNC in-state applicants.

33. Given UNC's selective nature, it is not surprising that very few total admits come from deciles 1 through 3, which reflect applicants with the lowest test scores and high school GPA. Together, deciles 1 through 3 account for just 3 percent of UNC's admits overall and just 4 percent of UNC's in-state admits.

34. Admit rates are somewhat different for URMs and non-URMs in deciles 4 through 6, which account for about one-quarter of in-state admits. However, this is where we would expect to see such differences. To understand this, consider a university that admits students via a holistic process and takes race/ethnicity into account in a manner that *minimizes* its influence on admissions outcomes. In other words, race/ethnicity is considered, but it is not dominant. In such a holistic process, admissions staff form a holistic assessment of each student, taking into account not only academic and extracurricular qualifications, but also personal qualities, subjective factors, and context (such as challenging childhood circumstances), as well as race/ethnicity. This holistic assessment then determines the admissions decision. In this process, there will likely be a group of students who are competitive, but not clear candidates for outright admission or rejection. For these students a small factor in their favor could make the difference. For example, the consideration of race/ethnicity, even if applied minimally in the admissions process overall as one factor among all of those presented in an application, could be the difference for some of these students. The students in deciles 4 through 6 are likely these "on the bubble" students.[30]

35. However, even for these students, Prof. Arcidiacono has not shown that race/ethnicity dominates other characteristics in determining their admissions outcomes – these students' applications are still reviewed holistically by UNC. In fact, while race/ethnicity could be a factor

[30] The Oxford English Dictionary defines the phrase "on the bubble" as occupying the last qualifying position on a roster (of a sports team) or for a tournament, and liable to be replaced by another. *See* "On the bubble," *Oxford English Dictionaries*, https://en.oxforddictionaries.com/definition/on_the_bubble.

that may play a role in determining the admissions outcomes of students "on the bubble," many other characteristics could also play such a role, including musical talents, leadership qualities, an affinity with one of UNC's distinctive undergraduate programs, or any of the other characteristics that are not included in the Arcidiacono Index.

36. Moreover, even if race were "dominant" for some "on the bubble" cases (which Prof. Arcidiacono has not shown), that would not imply that race is a dominant factor in admissions overall. Since deciles 4 through 6 account for only a quarter of in-state admits, the differences in admissions rates across URMs and non-URMs has a small overall effect on UNC admissions. This is why, in Exhibit 2: Table 1, there is not much effect from equalizing the admissions rates across URM and non-URM students in these deciles. Visually, we can see this in Exhibit 2: Figure 2a.[31] If we focus on deciles 4 through 6, we do see the left-hand column looks a bit different from the right-hand column within each decile. However, the differences are very small relative to the heights of the columns in deciles 7 through 10. This is just another way of saying that, for admissions, deciles 7 through 10 are important because they generate the vast majority of admitted students, deciles 4 through 6 have a much smaller impact, and deciles 1 through 3 have a very small impact.

37. Thus, to the extent that Prof. Arcidiacono presents the results of each decile as *equally* relevant to the question of whether race/ethnicity is being used as a dominant factor in UNC admissions is misleading. By ignoring the number of admits within each decile, he suggests that race/ethnicity is dominant when it is clear, from a figure like Exhibit 2: Figure 2a, that it actually plays a minor role and, according to his own models, at most appears to potentially play a role with respect to a small subset of applicants.

38. The same conclusions hold true when examining the out-of-state applicant and admitted population. Exhibit 2: Figure 2b is just like the previous figure except that it shows out-of-state admits. Again, it is constructed using Prof. Arcidiacono's own statistics. Within each decile, the column on the left shows UNC's actual out-of-state admits. The column on the right shows the number of out-of-state admits UNC would have if the admissions rate were set to be equal across URMs and non-URMs within the decile.

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[31] Again, I note that this Exhibit is based on Prof. Arcidiacono's academic index, which does not accurately reflect UNC's admissions process or decisions. This statement does not say anything about what would happen under an *actual* race-blind admissions plan.

39. First note that *all* of the columns are lower in Exhibit 2: Figure 2b than in Figure 2a. This is because 82 percent of UNC's matriculation spots are reserved for in-state applicants. UNC admits many fewer students from out-of-state than it admits from in-state. Thus, even if race played a larger role with respect to out-of-state applicants, the influence of any phenomenon that occurs in the out-of-state pool has a much smaller effect when considering the entire pool.

40. Just as we did when analyzing the in-state results, it is useful to start by examining out-of-state decile 10 since, all by itself, the 10th decile accounts for a large share – 36 percent – of all out-of-state admitted applicants. If we were to set admissions rates to be identical across URM and non-URM students in this decile, the change in non-URM admissions would be very slight.[32] This is shown in the figure: the left-hand and right-hand columns in this decile are very similar. There are two reasons why the change in admissions is so slight. First, the admissions rates are similar across URM and non-URM applicants. Second, there are only a small number of URM applicants in an average year.

41. About three-quarters of UNC's out-of-state admits are drawn from deciles 8, 9 and 10 in average year. Thus, it is reasonable next to focus on these three deciles (not the 10th only). If we were to set the admissions rate to be identical across non-URM and URM applicants within these deciles, admissions would change only slightly. This is evident from the figure and Exhibit 2: Table 1. Again, this is because (i) admissions rates are sufficiently similar across non-URM and URM applicants and (ii) the number of URM applicants is small.

42. Similar to the results of the in-state analysis discussed above, out-of-state deciles 1 through 4 generate few admits (7 percent). And out-of-state deciles 5 through 7 can be thought of as the deciles that correspond to the "on the bubble" cases. Thus, as I discussed above, it is not surprising that this is where admit rates are somewhat different for URMs and non-URMs. However, due to the small number of admits from these deciles—which account for about one-fifth of out-of-state admits—the differences in admissions rates across URMs and non-URMs do not have much overall effect on UNC admissions.

43. In summary, the conclusions based on the Arcidiacono Index are misleading to the extent Prof. Arcidiacono purports to suggest that they show race/ethnicity is playing a dominant role in

[32] The change in non-URM admissions would be equal to roughly 4 percent or 19 of the non-URM students in the 10th decile. Again, the report of this and other statistics, by decile, is based on Prof. Arcidiacono's flawed admissions model and does not imply that UNC's true admissions process can be characterized this way.

UNC admissions. This incorrect impression can only be achieved if one ignores the fact that the higher deciles of the index provide the vast majority of UNC's admits. In fact, the evidence suggests that if admissions rates were set equal across URM and non-URMs applicants in the higher deciles of the index, admission outcomes would be only slightly affected. Since these deciles account for about three-quarters of admits, even Prof. Arcidiacono's own analysis shows that race/ethnicity cannot be playing a dominant role. Moreover, the evidence is consistent with the view that race/ethnicity as one factor among many could make a difference among the small subset of applicants who are qualified, but whose test scores/GPA are not so high as to have a very high chance of admission.[33]

D. Prof. Arcidiacono Presents Non-Representative and Misleading Estimates of the "Magnitude of Racial/Ethnic Preferences" that Grossly Overstate the Role of Race/Ethnicity in UNC Admissions

44. Prof. Arcidiacono next moves to estimating an alleged racial/ethnic preference in admissions for individual applicants (Arcidiacono Report, Section 4). To do so, Prof. Arcidiacono constructs several examples in which a hypothetical non-URM applicant is "treated as" or "transformed" into a URM applicant. I call these his "transformation examples." These examples are shown in Tables 4.1 and 4.2 of his report and they purport to show the magnitude of racial/ethnic preferences. For example, he claims that his analysis shows that "hypothetical non-URM applicants who are highly likely to be rejected *would be transformed into highly likely admits if they were URMs, and all other characteristics stayed the same*" (emphasis in original).[34] In fact, these tables do not provide evidence that race/ethnicity play a dominant role because Prof. Arcidiacono's examples are selectively picked and are not representative of what would happen across the entire pool of UNC's actual applicants and in light of UNC's inherent capacity (or class size) constraints that must be considered.

45. To generate the examples in his Tables 4.1 and 4.2, Prof. Arcidiacono first uses a regression to model UNC's admissions process. There are numerous problems with his modeling procedure, which are discussed in Section IV below. However, for the purposes of this

[33] Again, I note that I do not accept that Prof. Arcidiacono's Admissions Index accurately captures UNC's admissions process or decisions.
[34] Arcidiacono Report, p. 43.

section, I take his modeling as given. Specifically, he employs estimates from his "Model 4" for his primary examples.[35]

46. Once he has estimated Model 4, Prof. Arcidiacono uses it to generate an estimated admission probability for each student. It is important to understand these estimated probabilities because Prof. Arcidiacono uses them multiple times in his report and they also form the basis for the simulations of alternative admissions plans in the Kahlenberg Report.[36] The basis for Prof. Arcidiacono's estimated admissions probability is a linear combination of characteristics that Prof. Arcidiacono estimates, which I will refer to as the "index value" from the Arcidiacono Models.[37] It is this "index value" (which is *not* a metric that is used in UNC's holistic admissions process) that Prof. Arcidiacono adjusts when he "transforms" applicants from one race to another and that Mr. Kahlenberg adjusts when simulating his purportedly race-blind admissions plans.

47. Two things about Prof. Arcidiacono's estimated admissions probabilities are especially worth noting:

i. They are *estimates*, not a student's true admissions probability or true admissions outcome. Prof. Arcidiacono's models are not able to embody UNC's holistic individualized admissions process at all fully. Thus, the estimates include many erroneous predictions. Some students with a high estimated admissions probability are, in fact, rejected. Some students with a low estimated admissions probability are, in fact, accepted.

ii. All of Prof. Arcidiacono's models put too much weight on observable student characteristics—especially test scores, grades, and race—relative to UNC's true admissions process. This is because Prof. Arcidiacono cannot observe many factors that UNC admissions staff can observe: factors that are too subjective, qualitative, or individual to be in the set of measured factors in the UNC admissions dataset. Since the models cannot put weight on unobservable factors,

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[35] Arcidiacono Report, p. 43.
[36] Kahlenberg Report, Section VI.
[37] Prof. Arcidiacono estimates his admissions models using a "Logit regression." Such a regression assumes that the probability of admission is a particular function (the "Logit" function) of a linear combination of the characteristics of an applicant. This linear combination of characteristics is something that Prof. Arcidiacono estimates; it does not embody UNC's holistic admissions process.

they overweight observable factors like test scores, grades, and race. As a result, test scores and grades play a larger role in a student's *estimated* admissions probability than they play in his or her *true* admissions probability and *true* admissions outcomes.

48. A useful way to think about Arcidiacono's estimated admissions probabilities is that they are a lot like the Arcidiacono Index: they are a combination of test scores, grades, and other observable factors with a lot of the weight on test scores and grades but some weight on other factors as well. A higher estimated admissions probability is like a higher Arcidiacono Index value.

49. Using his model, Prof. Arcidiacono takes a student's actual data, changes the variables that record his or her race, and then obtains a newly recalculated estimate of the student's admissions probability with his or her "switched" or "transformed" race. For instance, Prof. Arcidiacono can switch the indicator that a student is white from 1 to 0 and switch the indicator that a student is African American from 0 to 1.[38] When he recalculates the student's estimated admissions probability after making this switch, he generates one of his "transformation examples" to which I referred earlier.[39]

50. It is worth noting that Prof. Arcidiacono does not, in fact, perform these switches correctly because he does not change all of the race variables correctly. This is a point discussed below in Section IV.E.2. However, for the remainder of this section, I treat his transformation examples as though they had been performed correctly.

51. Now, if all students' race variables are switched to *any* particular race, the recalculated estimated admissions probabilities effectively become race-neutral. Students can all be switched to being white, Asian, African American, Hispanic, etc. Such recalculated "all-one-race" estimated admissions probabilities are analogous to the Arcidiacono Index because they are really just another way of combining test scores, grades, and other observable factors (*excluding* race) to get an index of a student's (mainly academic) observable qualifications.

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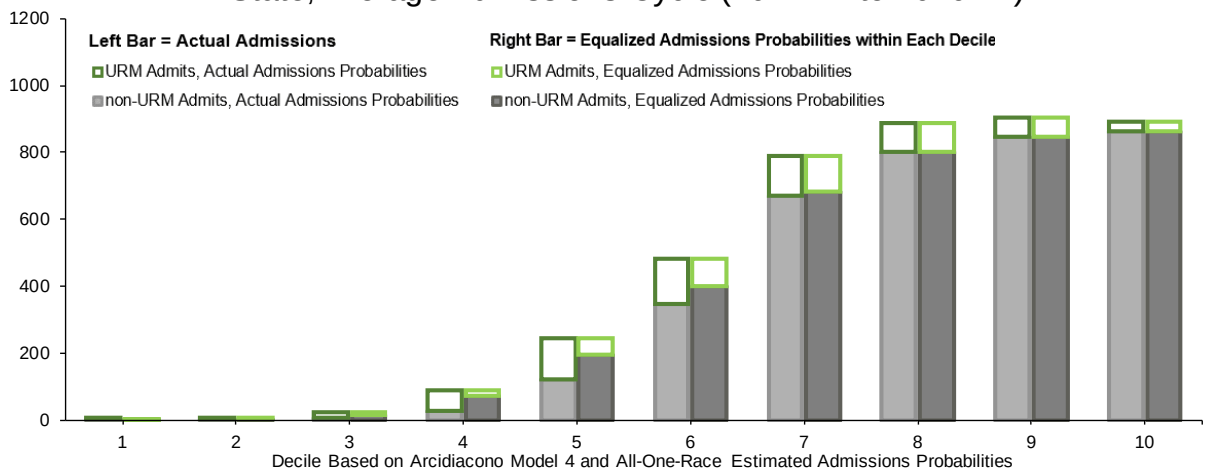
[38] Setting indicator variables to zero is the same process by which Mr. Kahlenberg "turns off" the coefficients on certain characteristics, like race indicators and an alumni indicator, in his simulations.
[39] *See*, Arcidiacono Report, Tables 4.1 and 4.2.

52. To show how Prof. Arcidiacono's estimated admissions probabilities relate to actual admissions decisions, I construct **Exhibit 2: Figure 3a**.[40] This figure has a similar design to Exhibit 2: Figure 2a. To construct it, I use Prof. Arcidiacono's own Model 4 and I switch all students to being African American. (Note that I would get a similar figure had I switched them all to being any particular race.) I take the all-one-race estimated admission probability and divide it up into deciles (or tenths) just as Prof. Arcidiacono divided up the Arcidiacono Index. I show UNC's actual admission of URM and non-URM students in each decile: the left-hand column in each decile. I also show the admission of URM and non-URM students that would result using Prof. Arcidiacono's Model 4 if the admissions rate were set to be the same for all race/ethnicity groups in each decile: the right-hand column in each decile. Thus, Exhibit 2: Figure 3a is just like Exhibit 2: Figure 2a except that I use Prof. Arcidiacono's Model 4-based estimates of admissions probability to divide students into deciles instead of using the Arcidiacono Index. Both Exhibit 2: Figure 3a and Exhibit 2: Figure 2a are for in-state students.

Exhibit 2: Figure 3a[41]
UNC Admits by Decile Based on Arcidiacono Model 4 and All-One-Race Estimated Admissions Probabilities
In-State, Average Admissions Cycle (2011-12 to 2016-17)



53. The first thing to see in Exhibit 2: Figure 3a is that the vast majority—80 percent—of UNC's admits come from the top 4 deciles (deciles 7 through 10).[42] Given UNC's selective

[40] Note that, in order to show the results of Prof. Arcidiacono's Model 4, this Exhibit is based only on the applicants who are included in his Model 4, not all applicants (see Section IV.E.1 for a discussion of the applicants he excluded).
[41] See Exhibit 2 for sources and notes.
[42] I note that this number and the numbers throughout this section are based on Prof. Arcidiacono's admission's models, which I do not consider to be accurate or reliable.

nature, it is not surprising that very few total admits come from deciles 1 through 3, which—together—account for just 1 percent of UNC's in-state admits. This leaves deciles 4, 5, and 6 to account for the remaining modest share (19 percent) of UNC's admissions process. In particular, decile 5 accounts for just 6 percent of UNC's admits. This is an important fact to keep in mind, going forward.

54. The second thing to see in Exhibit 2: Figure 3a is that in deciles 7 through 10, the admissions rates for URM and non-URM students are very similar so that admission outcomes would change hardly at all if the rates were set equal across URM and non-URM students. To see this, compare the left-hand column to the right-hand column within each decile.

55. Since (i) the role of race/ethnicity in these deciles (in-state deciles 7 through 10) is minor and (ii) these deciles account for 80 percent of admits in an average year, the role of race/ethnicity cannot be dominant in UNC in-state admissions.

56. Admit rates are somewhat different for URMs and non-URMs in deciles 4, 5, and 6 especially decile 5. Once again, and consistent with my previous analysis in Section III.C (Exhibit 2: Figure 2a) this is where we one might expect to see such differences as these are the students for whom any difference observed as part of individualized review could make the difference in whether they are admitted, consistent with UNC minimizing the role of race/ethnicity in a holistic admissions process. This point has already been explained with regard to Exhibit 2: Figure 2a.

57. As I discussed above with respect to Exhibit 2: Figure 2a, even for the "on the bubble" students in deciles in 4, 5, and 6, Prof. Arcidiacono has not shown that race/ethnicity dominates other characteristics in determining their admissions outcomes – these students' applications are still reviewed holistically by UNC. In fact, while race/ethnicity could play a role in determining the admissions outcomes of students "on the bubble," many other characteristics could also play such a role, including musical talents, leadership qualities, an affinity for a distinctive UNC program, or any of the other characteristics that are not included in the Arcidiacono Models.[43] In each decile, there are some URM students and non-URM students who are admitted, while in the same decile, there are some other URM students and non-URM students who are not admitted.

[43] In fact, since most students within these deciles are non-URM, when comparing outcomes between students in these deciles, most comparisons are between non-URM applicants.

58. To make his Table 4.1 (based on in-state students), Prof. Arcidiacono selects two estimated admissions probabilities for non-URM students: a 10 percent admissions probability and a 25 percent admissions probability. These students are concentrated in deciles 4, 5, and 6: 78 percent of non-URM students with one of these two admissions probabilities fall into decile 5, 13 percent of them fall into decile 4, and 9 percent fall into decile 6.[44] Thus, Prof. Arcidiacono has decided to focus on specific, and highly non-representative, applicants for whom race/ethnicity could be most likely to play a role.[45]

59. For this subset of URM students with either a 25 percent or 10 percent respective estimated admissions probability on whom he decides to focus, Prof. Arcidiacono switches their race from Asian or white to either African American or Hispanic.[46] He then recalculates these students' estimated admissions probabilities based on his Model 4. Each of these recalculations makes up one of the transformation examples shown in Table 4.1.

60. By selecting this subset of students for his transformation examples (the students shown in Table 4.1), Prof. Arcidiacono makes it appear that race/ethnicity plays a much more important role in admissions than it actually does. To see that, remember that decile 5—from which about three quarters of the transformation examples in Table 4.1 are drawn—accounts for 6 percent of UNC admits. This is why it is critical to examine the entire picture of the admissions process as I do in Exhibit 2: Figure 3a and not just focus on isolated examples.

61. In fact, using Prof. Arcidiacono's own calculations, the median change in admissions probability for an Asian in-state applicant if he or she were "transformed" to African American is an increase of 2.6 percent.[47] This is far smaller than the increased estimated admission probabilities of 63.9 percent (25 percent to 88.9 percent) and 62.7 percent (10 percent to 72.7 percent) that Prof. Arcidiacono misleadingly emphasizes in his Table 4.1.[48]

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[44] Again, I note that these numbers are based on Prof. Arcidiacono's admissions models, which I do not consider to be accurate or reliable.

[45] Based on Prof. Arcidiacono's admissions models, which I do not consider to be accurate or reliable.

[46] Actually, as noted below (Section IV.E.2), he does not perform the transformation correctly because he retains the student's original race in certain interaction variables.

[47] Again, I note that this number is based on Prof. Arcidiacono's admission's models, which I do not consider to be accurate or reliable. This statement does not say anything about what would happen under an *actual* race-blind admissions plan.

[48] Note also that the transformation is not performed correctly. See discussion in Section IV.E.2.

62. Next, I turn to out-of-state applicants. **Exhibit 2: Figure 3b** is like Exhibit 2: Figure 3a except that it is for out-of-state applicants and uses Prof. Arcidiacono's own Model 4 for them.[49] I show UNC's actual admission of URM and non-URM students in each decile: the left-hand column in each decile. I also show the admission of URM and non-URM students that would result based on Prof. Arcidiacono's Model 4, if the admissions rate were set to be the same for all race/ethnicity groups in each decile: the right-hand column in each decile.

63. It is important to remember that out-of-state admits account for only about one-third of UNC's total admits so that Exhibit 2: Figure 3b represents much less of UNC's overall admissions process than the previous figure does.

64. The first thing to see in Exhibit 2: Figure 3b is that the majority (57 percent) of UNC's out-of-state admits come from just the top decile (decile 10). The second thing to see is that setting the admission rate to be equal in decile 10 makes hardly any difference to the set of applicants admitted. So, for over half of the out-of-state admits, race plays hardly any role—according to Prof. Arcidiacono's own estimates.

65. Exhibit 2: Figure 3b shows that very few total out-of-state admits come from deciles 1 through 6, which—together—account for just 9 percent of UNC's out-of-state admits overall.

66. This leaves out-of-state deciles 7, 8, and 9 to account for the remaining share of UNC's out-of-state admissions process. These are "on the bubble" deciles for the out-of-state process if we rely on Arcidiacono's Model 4. It is a peculiar artifact of his model (which I am using for this limited purpose even though it does not accurately capture UNC's admissions decisions) that his estimated admissions probabilities are so low in deciles 1 through 6 that deciles 7, 8, and 9 represent applicants who are "on the bubble." Regardless, deciles 7, 8, and 9 are where one might expect to see differences in admit rates if UNC were minimizing the role of race/ethnicity in admissions by using it only minimally in a holistic, individualized admissions process. That is, it is for these students that a small factor in their favor could make the difference.

67. Even though I observe that admit rates based on Prof. Arcidiacono's model are different for URMs and non-URMs in these deciles,[50] it is critical to keep in mind that out-of-state deciles

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[49] Again, because this Exhibit shows the results of Prof. Arcidiacono's Model 4, this Exhibit is based only on the applicants who are included in his Model 4, not all applicants (see Section IV for a discussion of the applicants he excluded).

[50] The numbers in this paragraph are based on Prof. Arcidiacono's flawed admissions model and should not be interpreted as an accurate or reliable characterization of UNC's actual admissions process.

7, 8, and 9 account for only 33 percent of UNC's out-of-state admits and only 11 percent of UNC's total admits. Thus, differences in admit rates in these deciles are not representative of the out-of-state process and not at all representative of the overall UNC process.

68. Yet, to make his Table 4.2 (based on out-of-state students), Prof. Arcidiacono selects transformation examples that are drawn from out-of-state deciles 7, 8, and 9: most (63 percent) are from decile 8. Thus, Prof. Arcidiacono has decided to focus on specific, and highly non-representative applicants for whom race/ethnicity is most likely to play a role. By selecting this subset of students for his transformation examples, Prof. Arcidiacono makes it appear that race/ethnicity plays a much more important role in admissions than it actually does.

69. Moreover, as I discussed above with respect to Exhibit 2: Figure 3a, even for the students in deciles 7, 8, and 9, Prof. Arcidiacono has not shown that race/ethnicity dominates other characteristics in determining their admissions outcomes – these students' applications are still reviewed holistically by UNC. There are many characteristics other than race that could be determinative of their admissions decisions. In each decile, there are some URM students and non-URM students who are admitted, while in the same decile, there are some other URM students and non-URM students who are not admitted.

70. Overall, when assessing the role of race/ethnicity in UNC's admissions process, it is critical to examine the entire picture of the admissions process as I do in Exhibit 2: Figures 3a and 3b.[51] Not only is it important to avoid focusing on examples that are non-representative of the process overall, it is also important to remember that out-of-state students account for a small share of UNC's actual student body.[52] And even for the out-of-state students in the narrow non-representative group on which Prof. Arcidiacono focuses, Prof. Arcidiacono has not shown that race/ethnicity was a dominant factor or that it outweighed any of the other factors in UNC's holistic review.

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[51] Of course, it is also important to characterize the admissions process accurately, which Prof. Arcidiacono's model does not do. I am using his flawed admissions model throughout this section purely in order to demonstrate the effects of his own procedures. The numbers presented in Exhibit 1 Figures 3a and 3b should not be taken as an accurate characterization of UNC's true admissions process.

[52] For consistency with Prof. Arcidiacono and Mr. Kahlenberg, in this report, I analyze the set of *admitted* students rather than *matriculating* students. However, as I stated in my opening report, it is the matriculating class that ultimately affects the University's ability to fulfil its educational mission. I note that in-state students account for an even larger share of UNC's matriculating class than they do of UNC admits.

71. Prof. Arcidiacono does attempt to extend his analysis to "show how the average probability of admission would change for Asian Americans and whites if they were treated as African Americans and Hispanics."[53] In Table 4.3 he shows that, for example, the average change in admission probability for Asians in-state if transformed to African American is between 14.4 percent and 14.9 percent depending on the model used. This average change is considerably lower than the selectively-picked examples discussed above, however it is still misleading.

i. First, because the cases that Prof. Arcidiacono shows in Tables 4.1 and 4.2 of students who are not representative UNC's admitted class as a whole have large changes in probability, they pull up the average, masking the large percentage of cases (deciles 7 through 10 in-state and decile 10 out-of-state) where "transformation" would have a small effect.[54]

ii. Second, the average probability changes that Prof. Arcidiacono shows in his Table 4.3 are not corrected for the "capacity constraints" that he acknowledges that UNC faces.[55] Although Prof. Arcidiacono does provide some analysis of the class that would result in the presence of capacity constraints (Table 4.4), he does not incorporate these constraints in the changes in admissions probabilities that he presents in Table 4.3.

72. The reason why the capacity constraints matter is because there are a fixed, and limited, number of spots for admission. For example, framing the counterfactual as a switch from Asian (and other race/ethnicities) to African American for all applicants overstates the alleged magnitude of racial preferences.[56] If one does not adjust the admission probabilities to account for the fact that Prof. Arcidiacono is increasing the admission probabilities for all non-African American applicants, the resulting admission probabilities would result in a class larger than the

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[53] Arcidiacono Report, p. 50.
[54] Technically, the distribution of changes in probability due to Prof. Arcidiacono's transformations is highly skewed, meaning that the mean (average) is far from the median and mode of the distribution (other measures of central tendency that capture the "middle" student and the student with the "typical" change in probability, respectively).
[55] Arcidiacono Report, p. 52.
[56] The counterfactual is one where admissions are race-blind, thus all applicants (Asian, white, Hispanic, etc.) are treated as if they were African American.

number of seats available for admits. Exhibit 2: Figures 3a and 3b shows the results of imposing race-blindness under Prof. Arcidiacono's model while using Prof. Arcidiacono's method to ensure that the admitted class remains the same size.[57] However, in his Tables 4.1, 4.2, and 4.3, Prof. Arcidiacono *does not* account for the need to keep a fixed number of admitted students consistent with UNC's current admitted class size.

73. Under Prof Arcidiacono's model, the unscaled change shown in his Table 4.3 for transforming Asians to African Americans would be 14.4 percentage points (in-state, no high school fixed effects). However, the average effect of a change from transforming Asians to African Americans (were one to treat *all applicants* as African American) and then scaled using Prof. Arcidiacono's method to fit a class of a fixed size would be an increase in the average probability of admission for Asians of only 1.7 percentage points.[58] See **Exhibit 2: Figure 4a**. The results for out-of-state are similar. See **Exhibit 2: Figure 4b**, which shows a change from the 45.6 percentage points reported by Prof. Arcidiacono, to the scaled result of 3.1 percentage points. The results for white applicants are similar.

IV. Prof. Arcidiacono's Models of the Admissions Process Use Improper Assumptions and Contain Errors and are Therefore Not a Reliable Basis for Analysis of Any Alternative Admissions Plan

74. As I mentioned earlier, Prof. Arcidiacono builds admissions models to both "explain" the UNC admissions process, including the role of race/ethnicity within the process, and in order to consider counterfactual admissions scenarios or "what if" scenarios that might occur if UNC were to adopt a different admissions practice. These counterfactual admissions scenarios appear in the Kahlenberg Report, but they are based on the models estimated by Prof. Arcidiacono. In this way, Mr. Kahlenberg and Prof. Arcidiacono are using the Arcidiacono admissions models in an attempt to predict what would happen under alternative scenarios.

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[57] In this figure, I have adopted Prof. Arcidiacono's proposed method of adjusting the admitted class to account for "capacity constraints." (Arcidiacono Report, p. 52) I note, however, that the econometrically preferable way to account for a capacity constraint would be to impose that constraint during the estimation of the model, which Prof. Arcidiacono has not done.

[58] Note that the effect from treating all applicants as Hispanic is the same as from treating all applicants as African American. This is because in both cases all students are treated the same way, therefore after scaling to fit a class of a set size the net effect is the same regardless of the size of the initial adjustment.

75. So far, my analysis in this rebuttal report has taken Prof. Arcidiacono's models of the admissions process as given. However, a further reason to disregard Prof. Arcidiacono's claims relating to UNC's admissions process is that his models of that process are unreliable and misleading because they use improper assumptions and contain errors.

76. If a model is to be used for reliable counterfactual analysis (i.e. reliable prediction under alternative scenarios), then it must fulfil at least four criteria:

i. It must not rely on a sample that is not representative of the population over which the prediction will be made.[59]

ii. It must not rely on factors or variables that are unavailable for the population over which the prediction will be made.

iii. It must not be overfit. A model is overfit if it does not generate reliable predictions outside of the original sample on which it was fitted.[60]

iv. It must not contain inappropriate variables or errors that make it unreliable.

77. Prof. Arcidiacono's models fail on all four of these criteria. Specifically:

i. Prof. Arcidiacono estimates his models using only UNC's actual applicants even though, under each alternative scenario, other students who differ from the current group of applicants would have a strong incentive to apply. In other words, if UNC announced a change in their admissions practice, it is nearly certain that its applicant pool would change. Indeed, states that have changed their flagship university's admissions plan have experienced significant changes in their applicant pool.[61]

ii. Prof. Arcidiacono's models rely on factors that have not been generated for any student who has not applied to UNC in the past. Therefore, his models are

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[59] *See*, e.g., Stock J., and M. Watson, *Introduction to Econometrics*, New York: Pearson Education, 2003, p. 250: "Sample selection bias occurs when the availability of the data is influenced by a selection process that is related to the value of the dependent variable." We observe applicants who choose to apply under the current admissions plan, but not the set of applicants that would apply under a different admissions plan. The applicants that UNC currently receives are not representative of the applicants it would receive under alternative admissions plans.

[60] *See*, for instance, Varian, H., "Big Data: New Tricks for Econometrics," *Journal of Economic Perspectives* 28, no. 2 (2014): 3–28. "Our goal with prediction is typically to get good *out-of-sample predictions.* Most of us know from experience that it is all too easy to construct a predictor that works well in-sample but fails miserably out-of-sample. To take a trivial example, *n* linearly independent regressors will fit *n* observations perfectly but will usually have poor out-of-sample performance. Machine learning specialists refer to this phenomenon as the "overfitting problem" and have come up with several ways to deal with it."

[61] See Expert Report of Bridget Long, January 12, 2018 ("Long Report"), Section VI.C.

necessarily unusable for predicting how admissions would work for students who have not applied and/or all future students.

iii. Statistical testing shows that Prof. Arcidiacono's models are overfit and therefore do not generate reliable predictions. Thus, his models cannot be used to predict what would happen to students who applied under alternative admissions plans but had not applied to UNC under the current admissions plan.

iv. Prof. Arcidiacono's models contain variables that generate biased estimates. Also, the models contain errors and problems that make them unreliable for assessing admissions plans.

78. I discuss each of these problems with Prof. Arcidiacono's models in the remainder of this Section. However, before turning to each of these problems, I also note that Prof. Arcidiacono falsely claims that his analysis likely understates the magnitude of racial/ethnic preferences due to differences in the unobservable characteristics of URM and non-URM applicants.[62] These claims are unsupported and there are reasons to believe that these unobservable characteristics actually bias his estimates in the direction of *overstating* the magnitude of racial/ethnic preferences, not understating it.

A. Prof. Arcidiacono Falsely Claims that his Analysis Likely Underestimates Race Preferences Based on Unsubstantiated Assumptions about the Unobservable Characteristics of the Applicant Class

79. Prof. Arcidiacono claims that, if one were to account for the unobservable characteristics of applicants (those characteristics not captured in the data Prof. Arcidiacono used in his model), it would tend to *increase* the magnitude of racial/ethnic preferences.[63] This is speculation. The fact that these characteristics are unobserved means that Prof. Arcidiacono does not know which direction they bias his results. His Table 5.1, which shows differences in the "admissions index" across racial/ethnic groups, does not account for unobserved characteristics (such as leadership potential) and sheds no light on unobserved characteristics. In addition, Prof. Arcidiacono claims to be able to test for bias or "preference" in subjective measures that are captured during

[62] Arcidiacono Report, pp. 56–61.
[63] Arcidiacono Report, pp. 60–61.

UNC's holistic review in ratings such as "Personal Qualities."[64] This is false. Prof. Arcidiacono's "test" is nothing more than an assumption that differences in *unobservable* characteristics across racial/ethnic groups "run in the same direction as observables."[65]

80. Prof. Arcidiacono further claims that "Given the substantial differences in the observed characteristics between under-represented minorities and their Asian American and white counterparts in ways that favor the latter group, there is no reason to assume that the unobservable characteristics to go in the opposite direction."[66] This is not true. In fact, if the unobservable characteristics were relevant for admissions decisions, one would expect applicants to UNC and admitted students at UNC to "select" on unobservable characteristics. That is, students with relatively low levels of observable characteristics, such as test scores and grades, would be more likely to apply to, and be admitted by, UNC when they have relatively *high* levels of unobservables (e.g., they have overcome particularly difficult circumstances).[67] Therefore, contrary to Prof. Arcidiacono's assertion, there is reason to believe that unobservable characteristics do "go in the opposite direction" from observable characteristics, making Prof. Arcidiacono's assertions about unobservables unfounded.

81. In Section 5.2 of his report, Prof. Arcidiacono purports to be using a series of ordered Logit regressions to test how race/ethnicity affects UNC ratings received by applicants. Prof. Arcidiacono concludes that it is "striking" that the coefficient on African American is positive and significant when including various controls.[68] He interprets this finding to mean that African Americans are receiving an additional racial preference that increases their "Personal Quality" rating.[69] He claims that, by controlling for this rating, he is understating the role of race/ethnicity in admissions decisions.[70]

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[64] Arcidiacono Report, Section 5.2.
[65] Arcidiacono Report, p. 63.
[66] Arcidiacono Report, p. 60.
[67] To see this, consider the following example. Suppose that to qualify for an Olympic team in cycling, there is a qualifying race in which the top 10 finishers make the team. Suppose that a racer's finishing place depends on two things: the quality of the racer's bicycle and the racer's skill. Imagine we look at the 10 racers who make the team and that we can observe the quality of everyone's bicycle, but not their skill. Among those who make the team, the (observed) bicycle quality will be negatively correlated with the (unobserved) skill. This is because if you make the team with a low-quality bicycle, you are more likely to be very highly skilled.
[68] Arcidiacono Report, p. 63.
[69] Arcidiacono Report, p. 63.
[70] Arcidiacono Report, p. 64.

82. This conclusion is not warranted. Prof. Arcidiacono's approach relies crucially – as he states – on the assumption that "unobservables run in the same direction as observables,"[71] an assumption that has no basis. Prof. Arcidiacono ignores the possibility that African American students actually earned high Personal Quality ratings relative to their observable characteristics like test scores and grades. Without his (unsupported) assumption—in other words without considering the possibility that unobservable factors (e.g. having a particularly compelling essay) might run in the opposition direction of observable factors (e.g., SAT score)—Prof. Arcidiacono can say nothing about racial "preference" in assigning UNC ratings, such as the Personal Quality rating.

B. Prof. Arcidiacono's Models Are Based Only on UNC's Actual Applicants Even Though They are Not Representative of the Students Who Would Apply under Alternative Admissions Plans

83. Prof. Arcidiacono presents seven different models for UNC admissions.[72] All of these models are fitted only using data on past applicants to UNC—despite the fact that these models are used (in the Kahlenberg Report) to make predictions about the admissions outcomes of hypothetical applicants under alternative admissions plans. Prof. Arcidiacono does not acknowledge this problem or make any attempt to remedy it.[73]

84. Using a sample to fit a model that is not representative of the population over which prediction must be made is a very well-known problem in statistics.[74] This problem can result in highly biased predictions for evaluations of admissions plans.

85. A well-publicized example is a Top 10 Percent or similar admissions plan, such as Texas employs. Before such a plan is put in place, students tend not to apply if they rank in the top ten percent of their high school class but have low test scores or otherwise have poor qualifications.

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[71] Arcidiacono Report, p. 63.

[72] Arcidiacono Report, Figure 4.1.

[73] Note that this is in contrast to my opening report where all alternative admissions plans are based on data from North Carolina students who are non-applicants as well as past applicants

[74] "When observations in social research are selected so that they are not independent of the outcome variables in a study, sample selection leads to biased inferences about social processes. Nonrandom selection is both a source of bias in empirical research and a fundamental aspect of many social processes." *See* Winship, C. and R. Mare, "Models for Sample Selection Bias," *Annual Review of Sociology* 18, (1992): 327–350. "Econometric studies of nonrandom sampling have analyzed the deleterious effects of sample selection on the properties of conventional estimators such as least squares; have produced a variety of alternative estimation techniques; and, in the process have yielded a rich crop of empirical models. In some cases the analysis has led to a reinterpretation of earlier results." *See* Greene, W., *Econometric Analysis*, New Jersey: Pearson Prentice Hall, 2008, p. 883.

They do not apply because they are unlikely to be admitted. After a Top 10 Percent plan is put in place, such students tend to apply because they are guaranteed admission if they do so. This has been the actual experience of Texas. There, the implementation of a Top 10 Percent plan caused substantial changes in the pool of applicants.[75] If a researcher had attempted to predict the effects of Texas' Top 10 Percent plan using a model based only on applicants from the pre-Top 10 Percent era, that researcher would have produced biased and inaccurate predictions.

86. The same effect can be expected with other alternative admissions plans. Another example is a plan based on socioeconomic variables such as the admissions plan proposed by Mr. Kahlenberg in the Kahlenberg Report. Absent such a plan, students tend not to apply if they have low test scores, grades, extracurricular qualifications, and other qualifications. If the admissions plan were changed (as Mr. Kahlenberg proposes) so that being from a disadvantaged background would fully offset having test scores that are at the bottom of the SAT score distribution rather than the top, then disadvantaged students with those lower test scores would have an incentive to apply because their probability of admission would be much greater. Similarly, if the admissions plan is changed (as Mr. Kahlenberg proposes) so that being from a disadvantaged background would fully offset having grades that are at the bottom of the grade distribution, then disadvantaged students with lower grades would have an incentive to apply. When Prof. Arcidiacono's model (which is based on a sample that excludes these individuals, who would apply under the new plan but not the old) is used, it will produce biased and unreliable predictions of what will occur under alternative admissions plans. More generally, admissions models based solely on past applicants will produce biased and unreliable predictions for any alternative plan that induces new and different students to apply.

87. Fitting a model on a sample that is not representative of the population over which predictions are made is a well-known statistical problem such that a failure to address it is not a reasonable oversight. The problem is explained and addressed routinely in research on education, medicine, science, economics, psychology, and all other areas in which human behavior matters.[76] For instance, no careful medical researcher would (i) fit a model of the effects of a heart medication to a sample of people all of whom had entered hospital emergency

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[75] Long Report, pp. 18–21.
[76] *See, e.g.,* Winship, C. and R. Mare (1992).

rooms with symptoms of heart attack and then (ii) use that model to predict how the medication would affect people who do not satisfy the criterion that they entered a hospital with symptoms of heart attack. In other words, the researcher would want to study people who were representative of *all* the people to whom the medication would be given, not a non-representative subset.

C. Prof. Arcidiacono's Models Rely on Ratings that Have Not Been Generated for Any Student Who Has Not Applied to UNC in the Past. Therefore, His Models Cannot Predict How Admissions Would Work for Students Who Have Not Applied, Including All Future Students

88. In his models 3–7, Prof. Arcidiacono includes the five subjective ratings that UNC admissions staff generate in their process of holistically assessing applicants.[77] Obviously, these subjective ratings do not exist for any student who has not applied to UNC in the past. Therefore, these ratings should not be included in any model that is intended to predict the effects of an alternative admissions plan. By including these ratings, Prof. Arcidiacono guarantees that his model cannot be used over the student population that could apply under an alternative plan. This is particularly egregious given that North Carolina maintains rich data that allows one to consider this broader likely applicant pool.

89. If we consider a Top 10 Percent plan, it is easy to see the problems created by including these ratings in a model intended for predicting the effects of an alternative admissions plan. If one wishes to predict the effects of a Top 10 Percent plan, one needs to consider all of a state's students who would be qualified for admission in the university because they are ranked in the top ten percent of their high school class. It would be incomplete to consider only those students who both (i) had already applied under a previous admissions plan and (ii) were in the top ten percent of their class. It would be incomplete because such students would have met double criteria: they would have been in the top ten percent of their class *and* well-qualified enough to have found it worthwhile to apply when admissions was not based on class rank alone. Thus, the predictions would be based on students who were both highly ranked and likely to be well qualified on holistic grounds. These students would only be a subset—a small subset—of the students who would be eligible for admission under a Top 10 Percent plan. Indeed, in North

[77] Arcidiacono Report, Figure 4.1.

Carolina, only 37.2 percent of the public school students eligible for admission under a Top 10 Percent plan would meet the double criteria (being applicants under the holistic admissions plan and being ranked in the top ten percent). In other words, any predictions for what would happen if UNC were to adopt a Top 10 Percent plan would be based on a small subset of students who were unrepresentative.

90. The same reasoning also explains why including the subjective ratings in a model is problematic if the model is intended for predicting the effects of an alternative plan based on socioeconomic factors. If one wishes to predict the effects of a socioeconomic plan such as those proposed by Mr. Kahlenberg (which rely on Prof. Arcidiacono's models), one needs to consider all of a state's students who meet the socioeconomic criteria to which preference is given in admission. It would be incomplete to consider only those students who both (i) had already applied under a previous admissions plan and (ii) met the socioeconomic criteria. Once more, such students would have met double criteria: they would have been highly disadvantaged socioeconomically and well-qualified enough to have found it worthwhile to apply when socioeconomic disadvantage is not associated with the extremely large benefit in admissions assumed by Mr. Kahlenberg. Thus, the predictions would be based on students who were both highly disadvantaged and likely to be well qualified on holistic grounds. These students would only be a subset—a small subset—of the students who would be given preference in admission on socioeconomic grounds. For instance, if I use Mr. Kahlenberg's indicators of socioeconomic disadvantage, only 4.9 percent of the students in North Carolina who would be given preference in admissions based on socioeconomics are also applicants under the current admissions plan.[78] In other words, the predictions would be based on a subset of students who were not representative of those affected by socioeconomic preferences.

91. More generally, admissions models that rely on variables that are available only for past applicants will produce biased and unreliable predictions for any alternative plan that induces new and different students to apply. This is a well-known statistical point.[79] For instance,

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[78] Only about 5 percent of public school students with any one of the three socioeconomic preferences Mr. Kahlenberg proposes applied to UNC in the 2014-15 admissions year. Only around 2 percent of students who would receive all three of these proposed preferences did.

[79] The censored or truncated variables issue is well known in the economics literature. In the labor supply context, for instance, the classic truncation problem is that wages are unavailable for those who do not work (akin to the lack of ratings for those who do apply). Therefore truncation prevents prediction of how the non-participants' labor supply would change if we were to—

statisticians would expect to produce biased predictions if they estimated a model of health care usage among people *with* health insurance and then employed their estimates to predict the effect of giving government-provided health insurance to the uninsured. Because North Carolina has rich data available on all public school students, it is unnecessary to base a model only on past UNC applicants and thereby generate biased predictions.

D. Prof. Arcidiacono's Models Are Unreliable for Assessing Racial Preferences or Alternative Admissions Plans because They Are Overfit

92. A model is overfit if it corresponds too closely to a particular set of data, with the effect of not predicting future data reliably.[80] In my opening report, I provided the following illustration, "For example, there might only be one Native American applicant for the 2015 class who has a combined SAT score of 1160, has a GPA of 3.5, has a class rank at the 10th percentile, is male, and is a North Carolina resident. Suppose that he were admitted by UNC. An overfit model would produce estimates that said that all Native Americans with his SAT score, GPA, class rank, sex, and residency would be admitted—with a probability of 100 percent. This is because the overfit model would simply have identified this particular combination of characteristics with a particular admissions outcome ("admit") based on an individual student. The model would appear to have fit the data but would really just be singling him out. Crucially, if the same model were used on applicant data for the next application cycle, it would do a poor job of predicting outcomes because it is based on a sample size of one."[81]

93. An overfit model cannot be reliably used to assess alternatives to the status quo. This is because, by the definition of overfitting, an overfit model does not predict well outside of the data sample on which it was fitted. Put another way, an overfit model does not predict well what would happen in counterfactual exercises where the data were different because the admissions process changed, where the applicant pool changed, or where both the process and applicant pool changed. Yet, analyses of racial preferences or alternative admissions plans are exactly such

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say—change the tax rate on wage income. *See*, e.g., Heckman, J., "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models," in *Annals of Economic and Social Measurement* in NBER 5, no. 4, (1976): 475–492.

[80] As cited at fn. 57 of the Hoxby Report, overfitting is "the production of an analysis which corresponds too closely or exactly to a particular set of data, and may therefore fail to. . .predict future observations reliably." *See* "Overfitting," *Oxford English Dictionaries*, https://en.oxforddictionaries.com/definition/us/overfitting.

[81] Hoxby Report, fn. 57.

counterfactual exercises. Thus, if Prof. Arcidiacono's models are overfit, they are not reliable for the purposes to which he (or ultimately perhaps Mr. Kahlenberg) puts them.

94. A model that is overfit gives readers a false sense of its reliability. It appears that it is able to explain a lot of a process when, in fact, it cannot reliably predict the effects of alternative plans. The Arcidiacono Report does not acknowledge this weakness in his models. For example, in Tables 4.1 and 4.2, Prof. Arcidiacono presents admissions probabilities under hypothetical "transformation" of non-URMs into URMs as if these numbers were known with certainty.[82] In fact, Prof. Arcidiacono's models are not well-suited to predict what would happen under an alternative admissions plan. Prof. Arcidiacono also makes other suggestions that the models are far more reliable than they are.[83]

95. There are several tests for overfitting that are commonly used and accepted among statisticians.[84] I apply these tests to Prof. Arcidiacono's models and find that the models he uses for counterfactual exercises (both the transformation examples and Mr. Kahlenberg's simulations) are overfit. In particular:

i. Model 4, which is used for Prof. Arcidiacono's transformation examples is overfit. This model also forms the basis of the Kahlenberg simulations. In addition, Model 4 has several other problems discussed below.

ii. Model 5 is akin to Model 4 except that Prof. Arcidiacono excludes some students.

iii. Model 6 (the "high school model") is even more overfit than Model 4.

iv. Model 7 (the "Census Tract model") is also more overfit than Model 4. It is also unreliable because Prof. Arcidiacono does not define Census Tracts correctly.

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[82] *See*, e.g., Arcidiacono Report, p. 43.

[83] For example, Prof. Arcidiacono describes models 6 and 7 as "account[ing] for unobserved differences in high school quality and other unobserved variables that are correlated with location" (Arcidiacono Report, p. 44). But he provides no evidence that the fixed effects in these models are in fact measuring any time-invariant "high school quality" or "unobserved variables that are correlated with location." Rather, these fixed effects simply measure what percentage of UNC applicants from a particular high school or from a particular Census tract were admitted in his estimation sample – there is no guarantee that applicants in other years or under other admissions plans would fare similarly.

[84] *See*, e.g., Copas, J.,"Regression, prediction and shrinkage," *Journal of the Royal Statistical Society, Series B (Methodological)* 45, no. 3 (1983): 311–354; Copas, J., "Cross-validation shrinkage of regression predictors," *Journal of the Royal Statistical Society, Series B (Methodological)* 49, no. 2 (1987): 175–183; and Harrell Jr., F., *Regression Modeling Strategies: With Applications to Linear Models, Logistic Regressions, and Survival Analysis*, 1st ed., New York: Springer, 2001 pp. 61–62. *See also* Bilger M. and W. Manning, "Measuring overfitting in nonlinear models: A new method and an application to health expenditures. *Health Economics* 24, no. 1 (2015): 75–85. Bilger and Manning (2015) extends the shrinkage measures from Copas (1987) to nonlinear models.

96. The consequence of these models being overfit is that although they may appear to perform well (in terms of model fit) if one uses just the sample of data on which they are estimated, they do not generate accurate predictions more generally. There are a number of reasons for this.

1. Prof. Arcidiacono Includes a Multitude of Race-Specific Indicator Variables

97. One reason why the Arcidiacono models are overfit is Prof. Arcidiacono has chosen to include a large number of race-specific variables in constructing his models. For example, an "academic" variable used in the admissions process (and therefore) in the Arcidiacono models is class rank. To estimate models of the UNC admissions process, both Prof. Arcidiacono and I use UNC's admissions data. These are data for all applicants over a number of years. The data are contained in spreadsheets that have thousands of rows (one for each applicant) and hundreds of columns (the data fields for each applicant). For some applicants, however, a specific field of data, such as class rank, is missing (empty) or recorded irregularly.[85] For instance, class rank might be irregular if it is a number that is outside the bounds of what is possible given the student's class size. Prof. Arcidiacono creates a variable (not in the original data) that indicates that class rank is missing or irregular. (He creates parallel indicators for other missing data fields.) However, rather than treat this missing/irregular indicator variable in the same way across all applicants, Prof. Arcidiacono allows this indicator variable to interact differently with the race variables used in his model. In other words, Prof. Arcidiacono's model does not just allow missing class rank to have an effect on an applicant's probability of admission generally; it allows Asians to have one sort of effect of missing class rank, African Americans to have another sort of effect of missing class rank, and so on for whites, Hispanics, etc. By making this choice, Prof. Arcidiacono makes each applicant in the sample more unique. Although this may allow him to achieve greater predictive power within the sample, it limits his model's ability to reliably predict outcomes on data that is not within the sample used to generate the model.

[85] To be clear, the fact that an applicant's data was retrieved from UNC's system and produced to me and Prof. Arcidiacono without a GPA or an SAT score is not to suggest that UNC is necessarily admitting some applicants without requiring that they submit grades or standardized test results.

98. Prof. Arcidiacono's modeling choice does not affect just a single academic variable like class rank.[86] Rather, Prof. Arcidiacono allows for this interaction between academic variables and race/ethnicity for other academic variables beyond class rank, including GPA, which may be missing from an individual applicant's data for whatever reason. This has the effect of introducing more race and ethnicity variables (not only the basic race and ethnicity indicators but also the misleadingly labeled "academic variables") into his model. Thus, it is not surprising that individuals are nearly singled-out. Recall that, logically, a model is overfit when it purports to explain a process truly but in fact only singles out individuals' outcomes because they happen to have some fairly unusual array of factors. In addition, the inclusion of these large numbers of predictor variables has the effect of underestimating the holistic nature of UNC's admissions process, since they overestimate the portion of the admissions decision that can be explained by a formula.

99. Thus, if there are only a few African American students whose GPA is missing and whose class rank is recorded irregularly, the model will appear to be a good fit for them but, in fact, it is merely picking them out as a small group of individuals. If next year's African American students with missing GPAs and irregular class rank are different, then the model will do a poor job of predicting their outcomes because it never incorporated the true role (if any) of such factors. It just picked out a few people.

2. Prof. Arcidiacono Includes a Multitude of High School Indicator Variables

100. In his high school model (Model 6), Prof. Arcidiacono includes an indicator or "fixed effect" for each high school attended by UNC applicants. This indicator allows every student's probability of admission to shift arbitrarily based upon his or her high school. Thus, it allows the model to appear to be a good fit when, in fact, it is merely picking out small groups of individuals. For instance, if nearly all applicants from a certain high school are poorly qualified in some admissions cycle, the model will over-attribute their rejections to the high school indicator or fixed effect. Yet, in reality, the rejections were probably due to factors in their

[86] Prof. Arcidiacono calls the aforementioned race and ethnicity interaction variables "academic variables," but this phrase is misleading because they are, in fact, racial and ethnic variables. Thus, any model that includes these "academic variables" is not race-blind.

applications, not mainly the identity of their high school (a "nearly automatic reject" school). Thus, it should not be surprising that the model does not predict well outside of the sample on which it was fitted. Next year's applicant pool might contain highly admissible students from "nearly automatic reject" schools who are, in fact, admitted. Yet, the model would have predicted that they would be likely to be rejected, simply because they came from schools that the model fitted as "nearly automatic reject" schools.

3. Prof. Arcidiacono Includes a Multitude of Location Indicator Variables

101. Prof. Arcidiacono uses the same approach—leading to the same error—with respect to his Census Tract model as he does in his high school model. In the "Census Tract" model (Model 7), Prof. Arcidiacono includes an indicator or "fixed effect" for the first nine digits of a tract's Federal Information Processing System (FIPS) code. These nine digits do not, in fact, correctly define Census Tracts, but that is an issue I consider below in Section IV.E.4. For now, what is important is this model allows every student's probability of admission to shift arbitrarily with the identity of his or her so-called tract. For instance, if nearly all applicants from a certain Tract are highly qualified in some admissions cycle, the model will over-attribute their acceptances to the Tract indicator or fixed effect. Yet, in reality, their acceptances were probably due to factors in their applications, not mainly the identity of their tract (a "nearly automatic accept" tract). Thus, it should not be surprising that the model does not predict well outside of the sample on which it was fitted. Next year's applicant pool might contain poorly qualified students from "nearly automatic accept" tracts who are, in fact, rejected. Yet, the model would have predicted that they would be likely to be accepted, simply because they came from tracts that the model fitted as "nearly automatic accept" tracts.

4. Tests of Overfitting

102. I conducted two tests to assess the extent to which Prof. Arcidiacono's models are overfit: (1) I examined how the "Mean Squared Error" ("MSE") of his models increases outside

of the estimation sample relative to inside the estimation sample, and (2) I calculated "shrinkage" statistics for Prof. Arcidiacono's models, which are a formal way of testing for overfitting.[87]

103. **Exhibit 3** shows how the MSE of Prof. Arcidiacono's models increases substantially when his models are applied to data outside of the sample used to estimate the models.[88] A higher value of MSE means that the model fits worse (i.e., the average amount by which the model predictions differ from the actual values is larger). For example, for Prof. Arcidiacono's Model 4 using in-state applicants, the MSE is on average 34 percent larger outside of the estimation sample than it is in the estimation sample. For his Model 6, the MSE is 156 percent larger, suggesting substantial overfitting.[89] As a comparison, the model in my opening report is less overfit, with an increase in MSE of only 5 percent when comparing out-of-sample predictions to in-sample predictions.[90]

104. **Exhibit 4** shows "shrinkage" statistics for Prof. Arcidiacono's models and the models presented in my opening report. Again, a higher number implies that the model is more overfit. As with the MSE values shown in Exhibit 3, one can see that the Arcidiacono models are more overfit than the models in my opening report and the higher-numbered Arcidiacono Models (particularly 6 and 7) are severely overfit.

105. The results in Exhibits 3 and 4 imply that if one were to use measures of model fit *within* the estimation sample to infer how Prof. Arcidiacono's models would perform outside of the estimation sample (e.g., on future applicants, or under an alternative admissions plan), the results would not be reliable. This is just one illustration of why it is problematic to use Prof. Arcidiacono's models to draw inferences about what would occur under hypothetical alternative admissions plans.

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[87] Shrinkage statistics are calculated using the *overfit* command in the statistical software Stata. These statistics are described in Bilger and Manning (2015).

[88] I calculate the MSE as the average of the square of the prediction error (the difference between the admission probability the model predicted for an individual application and what the outcome actually was) over all the applicants in the pool. I do this first for the sample year on which I estimate the model. I then take those model estimates, and use them to predict admission probabilities for the other years I did not use to estimate the model. For each year, I calculate the MSE of the model. I then compare the average MSE across the years not used to estimate the model to the MSE in the year used to estimate the model to measure the relative increase in model error out-of-sample.

[89] For Prof. Arcidiacono's models for out-of-state students, the analogous numbers are: 42% increase for Model 4 and 188% increase for Model 6.

[90] *See*, Hoxby Report, Exhibit 1 Table 1 row (9).

E. Prof. Arcidiacono's Models Contain Variables that Generate Biased Estimates. Also, the Models Contain Errors and Neglect Relevant Student Data Rendering Them Unreliable for Assessing Admissions

106. There are some important features of Prof. Arcidiacono's models that generate biased estimates and lead him to overestimate the extent to which he is able to explain the UNC holistic admissions process through a formula. In addition, there are a number of further errors in the analysis which Prof. Arcidiacono has performed, beyond these larger conceptual mistakes. I touch on some of these below. In each case, these features of Prof. Arcidiacono's models make them unreliable for drawing conclusions about the role of race/ethnicity in UNC admissions and for using these models in assessing whether there is a workable race-blind alternative admissions plan that would allow UNC to maintain its academic standards.

1. Prof. Arcidiacono Wrongly Includes Subjective Ratings Variables in His Admissions Model Regressions and Wrongly Excludes Students in Specific Categories

107. In his Models 3 through 7, Prof. Arcidiacono includes the subjective ratings that UNC's admissions staff generate as part of their holistic review process. I have already explained why it is inappropriate to include these variables if the intended use of the model is predicting the effects of alternative admissions plans, which will attract different applicants to UNC. In addition, these variables should not be included in Prof. Arcidiacono's models because they are "endogenous." A variable is "endogenous" if its creation involves one or more of the other variables in the regression. For instance, in a regression that predicts admissions, the creation of the "Personal Quality" variable could involve race since an applicant might have had experiences (such as having been adopted by parents of another race) whose interpretation depends on race.[91] In economics, it is well understood that the effect of including endogenous variables in this sort of regression is to change the estimated effects of race so that those estimates could not be "switched," "swapped," or "zeroed out" and then interpreted as though the student's race had *truly* changed.

[91] Hoxby Report, ¶ 39. In my opening report, I noted that it is inappropriate to include these ratings variables when attempting to assess whether UNC admissions can be explained by a formula because they are not "verifiable" in the sense that any two readers, with an application in front of them, would not necessarily report them in the same way.

108. To see the problems that can arise when including an endogenous variable, it is helpful to consider a medical example. Suppose that a clinic is trying to predict whether people will develop skin cancer (melanoma). Its staff use data from past patients who saw a dermatologist (skin doctor) about some skin-related issue. As part of the normal patient screening process, these past patients were all assessed by their dermatologist for skin cancer risk. Such assessments require professional judgement, a discussion with patients about their history (sun exposure, etc.), and a visual inspection of skin, moles, etc. The clinic staff estimate a regression in which the outcome is the patient having later developed skin cancer. (It is known from other studies that people who have paler skin are more likely to develop skin cancer as they age.) The explanatory variables in the regression are age, race, and the score that the dermatologist gave the patient on the assessment of skin cancer risk. The staff estimate the effects of these variables and find that people who are older and have higher risk scores are more likely to develop skin cancer. However, they also estimate that, conditional on age and risk score, a person's race has only a negligible effect. The staff take their estimated race effects and use them for counterfactual predictions such as predicting skin cancer *in a wider population of people for whom they do not have a dermatologist's assessment.* Their predictions would be biased. Why? The effect that they estimated for each race was *conditional on a certain score on the dermatologist's assessment*. For instance, if that assessment incorporated all of the cancer-relevant features of being white, then their estimated "white effect" would be negligible. If they used this negligible "white effect" estimate to predict skin cancer in the general population, their predictions would greatly understate the share of whites who would develop skin cancer *because they would be applying their model to data in which no dermatologist's assessment was available.*

109. Another way to see this is to think about a race "switch." Suppose the researchers "switched" a white person with a high risk score to "being African American" by swapping out his estimated "white effect" and swapping in the estimated "African American effect" *while keeping his high risk score the same*. This would clearly not be sensible because, if the white person were *truly* switched to being African American, his high risk score would not be the same (but almost certainly lower). Thus, the estimates might predict that the switched-to-African American person would develop skin cancer (because the estimate would be based on that

assumption that he has a high risk score) even though he would not develop cancer were he *truly* transformed into an African American.

110. We can translate this example back to admissions. The outcome in the example is developing skin cancer whereas in the case of admissions, it is being admitted to UNC. The past patients are like UNC's past applicants. The endogenous variable in the example is the patient's score on the dermatologist's assessment of skin cancer risk whereas the endogenous variable in the case of admissions is the applicant's result on one or more of the UNC ratings variables created in its admissions process. The bias in the prediction for the general population comes from the race variables having estimated effects that are not useful given that the staff want to use the estimates to predict skin cancer in a general population for whom no dermatologist's assessment score is available. Similarly, the bias in the prediction for UNC potential applicants comes from the race variables having estimated effects that are not useful given that the results are meant to be used to create predictions of what would happen under a race-blind alternative plan (i.e., for future applicants for whom no UNC ratings variables are available).

111. The bottom line is that Arcidiacono's inclusion of the UNC ratings variables in his models is not only problematic because they are not verifiable (see the discussion in my opening report, Section III.B) but also because they generate biased coefficients if the models are to be used for predictions over a more general population of potential applicants.

112. In addition, in every model Prof. Arcidiacono presents, he chooses to exclude from his analysis any student who is identified by UNC—during the process of holistic review—as belonging to what he calls "special recruiting categories."[92] That is, students are excluded from his admissions modeling who, during the process of holistic review, were classified by admissions staff as falling into any one of several categories.[93] These categories include being candidates for certain scholarships or having certain special talents.[94] This exclusion is inappropriate; these students' admissions are also part of the UNC holistic admissions process.

113. **Exhibit 5** presents the regression results and R-squared of Arcidiacono Models 2 and 3, where I demonstrate the effect of including the so-called "special recruiting category" students

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[92] Arcidiacono Report, pp. 8–9, 65–66.
[93] The "special categories" or "special recruiting categories" are listed in Arcidiacono Report, fn. 48.
[94] 4,768 in-state and 4,621 out-of-state students are excluded from Prof. Arcidiacono's sample based on 37 "special recruiting categories" across all years of analysis.

and excluding the endogenous ratings variable – that is, I re-run the Arcidiacono models, including these students, and dropping the ratings variables.[95] I find that, when adjusting for the inappropriate modeling choices, Prof. Arcidiacono's admissions model does not reliably fit actual UNC admissions decisions—44.4 percent of the variation associated with the in-state admissions decision is not explained by a formula; and for out-of-state admissions, that number is even higher, at 64.8 percent.[96] The cumulative effect of his modeling choices is to de-emphasize the process of holistic review. In addition, the estimated effects of race are also sensitive to these choices; correcting them leads to a lower estimated effect of URM status on admissions probability.[97]

114. The fact that Prof. Arcidiacono's models include endogenous variables, and do not include a significant portion of actual UNC admissions decisions makes these models unreliable and misleading for both (1) determining whether race is a "dominant" factor in admissions and (2) evaluating hypothetical alternative admissions plans.

2. Prof. Arcidiacono's Admissions Models Contain Race Variables that Do Not Get "Turned Off" in the Kahlenberg Simulations

115. As I mentioned earlier, the Kahlenberg Report includes simulations that Mr. Kahlenberg purportedly directed Prof. Arcidiacono to run using Prof. Arcidiacono's admissions model. Mr. Kahlenberg states that he instructed Prof. Arcidiacono to "turn off" the race variables.[98] That is, Mr. Kahlenberg directed that any variable in the data that might indicate race should not be considered. But in fact, because Prof. Arcidiacono allows for missing academic variables to be broken out by the race of the applicant (e.g. Asian applicant with missing class rank), Prof. Arcidiacono's admissions models have varying admissions probabilities that depend on their race. These variables are not "turned off" when Prof. Arcidiacono's model is used by Mr. Kahlenberg. Thus, the models used by Mr. Kahlenberg in his simulations predict admissions

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[95] In my opening report, I did not exclude these students from my analysis.
[96] This corresponds to the R-squared of his Model 2, where one includes the "special recruiting category" students. Note that these numbers are based on Arcidiacono's models, which I do not consider to be reliable even when one includes "special recruiting category" students.
[97] In particular, the coefficients on the African American and Hispanic Race indicators are also sensitive to these choices; for in-state students the estimated coefficient on African American falls from 2.85 to 1.72.
[98] Kahlenberg Report, p. 67.

using the race/ethnicity of students—even though Mr. Kahlenberg calls these simulations "race-neutral."

3. Prof. Arcidiacono Mistakenly Treats the New SAT Scores Introduced in 2016 as Directly Comparable to the Old SAT Scores in the Earlier Years

116. Prof. Arcidiacono mistakenly treats the new SAT scores introduced in 2016 as similar to the old SAT scores applicable in earlier years, without using the concordance table provided by College Board.[99] As a result, the average SAT scores from applicants in the 2016-17 admissions cycle are calculated based on non-comparable old and new scores.

117. Also, Prof. Arcidiacono fails to use the concordance table provided by the College Board for converting ACT scores into SAT scores. This concordance table is based on extensive research and a very large number of students who take both tests (more than 300,000 students in a recent study).[100] The College Board's concordance table is widely used for converting scores by colleges, universities, scholarship programs, and researchers.[101] Instead, Prof. Arcidiacono bases his model on a non-standard crosswalk that he himself creates using the small and non-representative group of students in the UNC applicant pool who take both tests. In a typical cohort of UNC applicants, only 8,367 students (or 28.4 percent of applicants) take both tests.[102]

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[99] The crosswalk is based on extensive research by the College Board and is widely used by colleges and universities to convert pre-2016 SAT scores into 2016-and-after SAT scores.

[100] See, "ACT and SAT® Concordance Tables," *College Board, Office of Research and Development*, Research Note RN-40, October 2009, available at https://files.eric.ed.gov/fulltext/ED562594.pdf.

[101] *See*, for example, Advisory Committee on Undergraduate Admissions, "Census Annual Report," *University of North Carolina*, April 25, 2014, available at https://carolinacommitment.unc.edu/files/2014/04/April-25-Annual-Report-Advisory-Committee-on-Undergraduate-Admissions.pdf. "Test score. Highest official score earned by each student on either the SAT (Critical Reading and Math combined) or the ACT Composite, with the ACT Composite converted to the SAT Critical Reading and Math scale using the standard concordance table approved by the College Board and ACT. This method of summarizing test scores best represents the way that scores are used by the University. Under guidelines for standardized testing approved by the Advisory Committee on Undergraduate Admissions, when any candidate for admission submits results from both the SAT and the ACT, the University considers the test with the stronger results." (*See*, "ACT and SAT® Concordance Tables," *College Board, Office of Research and Development*, Research Note RN-40, October 2009, available at https://files.eric.ed.gov/fulltext/ED562594.pdf.)

[102] This is based on Connect Carolina data from 2009-10 to 2015-16 admissions cycles.

4. Prof. Arcidiacono's Admissions Models that Purport to Include Fixed Effects for Census Tracts Do Not Correctly Identify Census Tracts

118. Prof. Arcidiacono's admissions models that purport to use geographic fixed effects for Census Tracts wrongly use a 9-digit FIPS code, rather than an 11-digit Census Tract. The effect of this is that this admissions model uses geographic units that (i) do not have the intended geographic integrity (ii) were often split long ago in recognition of changes in boundaries, features, or other facts, and (iii) may vary unduly widely in population size.[103]

V. Mr. Kahlenberg Has Failed to Provide Evidence of the Existence of a Workable Race-Blind Alternative

119. Next, I consider the putative race-blind alternative admissions plans presented in the Kahlenberg Report. I am not certain to whom to credit these simulations because I understand them to have been prepared by Prof. Arcidiacono at Mr. Kahlenberg's behest.[104] There is no discussion of the methodology behind these simulations in the Arcidiacono Report, and the Kahlenberg Report does not contain detailed methodology either. In numerous instances, I have found it impossible to identify who (Prof. Arcidiacono or Mr. Kahlenberg) is responsible for a choice regarding the procedures underlying a simulation. Thus, I hereafter describe the simulations as the Kahlenberg/Arcidiacono or "KA" simulations.

120. I disagree with the claim that the "KA simulations" provide evidence of the existence of a workable race-blind alternative that would allow UNC to maintain its racial diversity while also maintaining its high academic standards. I have four main criticisms of the KA simulations:

i. First, any simulation of an alternative admissions plan should be applied to data on the students who would be affected by it, not just students who decided in the past to apply to UNC under the university's current admissions process. This is particularly true for UNC because, as I have discussed above, North Carolina has rich data on

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[103] "Geographic Terms and Concepts – Census Tract," *United States Census Bureau*, available at https://www.census.gov/geo/reference/gtc/gtc_ct.html. "When new census tracts (splits) occur within an established set of census tracts, the Census Bureau recommends retaining the original four-digit census tract number and adding a two-digit decimal suffix. As a result, Census Tract 101 may be split into Census Tracts 101.01, 101.02," (*See* "Geographic Areas Reference Manual," *US Census Bureau*, November 2014, at p. 10-7, available at https://www2.census.gov/geo/pdfs/reference/GARM/Ch10GARM.pdf.)

[104] Kahlenberg Report, p. 65.

nearly all of its public high school students, and UNC's entering class is composed of approximately 82 percent in-state students.[105] Since the KA simulations are based entirely on past UNC applicants, the simulations do not even attempt to include most of the students whose admissions would be most affected by the introduction of an alternative plan. The resulting deficiencies in the KA simulation procedures are so great that it is my opinion that their predictions are unreliable in assessing what a hypothetical alternative admissions process would achieve. For example, if the admissions model used for the KA socioeconomic simulations is applied to prospective North Carolina applicants (not just past applicants), it generates predictions that are extremely different than those presented in the Kahlenberg Report. Specifically, if I apply the KA simulation procedures to prospective applicants from North Carolina, I find that UNC would admit a class that is dramatically less academically qualified in terms of test scores.

ii. Second, Mr. Kahlenberg proposes extremely large "bumps" or increases in the index value determining students' admissions probability for students whom he tags as socioeconomically disadvantaged. The "Kahlenberg Bumps" are so large that, if UNC used them as proposed by Mr. Kahlenberg, UNC would necessarily move away from holistic admissions and toward formula-based admissions.

iii. Third, numerous suggestions made by Mr. Kahlenberg regarding alternative admissions plans are unfounded, unworkable, or both. In particular, Mr. Kahlenberg proposes a highly idiosyncratic version of a Top X Percent plan (which he refers to as a "percentage plan"[106]) that does not correspond to Top X Percent plans that have been actually implemented by other institutions or discussed in academic research and literature. As I discuss in greater detail below, there are serious issues with how the Kahlenberg Top 4.5 Percent plan would have to be implemented in order to make it successful that render it unrealistic and unworkable in my opinion. Other suggestions made by Mr. Kahlenberg are similarly not well-considered. For instance, Mr. Kahlenberg suggests that socioeconomic status should take wealth, not just

[105] Approximately 78 percent of in-state students are from public schools.
[106] Kahlenberg Report, p. 76.

income, into account. But detailed and accurate wealth data that Mr. Kahlenberg suggests UNC might be able to access are not available, as I explain below. Owing to the absence of wealth data to which he alludes (but has not described how it would be obtained or whether it would be accurate), his suggestions regarding the use of wealth data in admissions are without basis and would, in any case, be unworkable in the foreseeable future.

iv. Fourth, Mr. Kahlenberg does not attempt to evaluate alternative admissions plans on the basis of whether they would allow UNC to maintain racial diversity. Instead, in each instance, his evaluation of a plan is based partly on whether it increases UNC's socioeconomic diversity. This is not my understanding of what UNC must assess in considering whether a workable race-neutral alternative exists. Rather, it appears to be the artifact of Mr. Kahlenberg's clear preference for increasing socioeconomic diversity. Moreover, as I discussed in my opening report, the correlation between socioeconomic variables and race is far from perfect and certainly not as strong as Mr. Kahlenberg suggests.

A. The Alternative Admissions Plans in the KA Simulations, When Applied to Most Prospective North Carolina Students Who Would Be Affected, Generate a Class Far Too Large and Imply that UNC Would Become Dramatically Less Selective

121. The first race-blind alternative admissions plans presented in the KA simulations are socioeconomic status-based plans (KA simulations 2 through 4). As Mr. Kahlenberg describes, the first step in his alternative socioeconomic model is to provide a "preference to students that come from families that are socioeconomically disadvantaged."[107] I do not disagree with the broad idea of including socioeconomic factors in a holistic admissions plan (see Section V of my opening report).[108] However, as I discuss in this section, Mr. Kahlenberg's choice to apply his socioeconomic status-based preference only to UNC's past applicant pool renders his analysis unreliable (in later sections, I discuss additional reasons why his analysis is unreliable). When

[107] Kahlenberg Report, p. 68.

[108] However, I would not suggest using socioeconomic variables in such a "blunt-force" manner where each socioeconomic variable is associated with a formulaic addition of index points determining students' admissions probability. Nor would I suggest using socioeconomics in a model that is untethered from an analysis of the college-going challenges associated with socioeconomic disadvantage, as Mr. Kahlenberg's proposal is untethered.

one instead applies the KA simulations to the pool of prospective applicants who would be likely to apply should UNC change its admissions plan, the results are very different from those in the Kahlenberg Report.

122. To generate the KA simulations of alternative admissions plans based on socioeconomic status, Mr. Kahlenberg uses the following procedure:

i. Prof. Arcidiacono estimates models of admissions based on past UNC applicants, and the KA simulations use his "Model 4."[109]

ii. The KA simulations then attempt to make the estimated admissions model race-blind. To do this, the estimated coefficients on some of the race variables (and certain other variables) are changed to "white." This step is apparently intended to make the remaining part of the estimated model race-blind. However, the KA simulations do not change the coefficients on the race interaction variables (which I discussed above and which are misleadingly labeled "academic variables") to "white" so the remaining part of the estimated model is not actually race-blind.[110, 111]

iii. As a substitute for the "zeroed-out" race variables, Mr. Kahlenberg introduces a preference or "bump" (hereafter, the "Kahlenberg Bump") in the index value determining students' admissions probability if the applicant meets certain criteria. This is how Mr. Kahlenberg purports to replace UNC's alleged "preference" for race with a socioeconomic preference. These bumps are just Mr. Kahlenberg adding to each applicant's estimated index value as follows:

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[109] In Arcidiacono Model 4, as used in the Arcidiacono Report, UNC applicants who are flagged as athletes in the data are removed from the estimation sample. See Arcidiacono Report, pp. 65–66. However, when running the KA simulations, Mr. Kahlenberg says that "[a]thletes were put back into the dataset" (Kahlenberg Report, fn. 260) and "Arcidiacono turned UNC's existing preferences for recruited athletes back 'on.'" (Kahlenberg Report, p. 67). I discussed earlier why I believe Model 4 is unreliable for the purposes of these simulations.

[110] These race interaction variables (for example, allowing Asian applicants who are missing class rank to have a different admissions probability than a Hispanic applicant missing class rank) are some of the ones I discussed above in Section IV.D when explaining why the Arcidiacono models are overfit.

[111] Mr. Kahlenberg also instructed Prof. Arcidiacono to "turn off" "preferences for recruited athletes, race, legacy, early decision, first generation status, fee waiver applicants, and female applicants" when generating admissions probabilities. Kahlenberg Report, p. 67.

a. Bump A: an increase of 5 "index points"[112] that determine the estimated probability of admissions if the applicant uses an admissions fee waiver, is eligible for the free or reduced-price lunch program, or has no parent who holds a baccalaureate degree.

b. Bump B: an increase of 5 *additional* index points if the applicant comes from a zip code where families' median income is in the lowest third nationally.

c. Bump C: an increase of 5 *additional* index points if the applicant attends a high school that is in the top third of North Carolina public high schools in that year, when schools are ranked from highest to lowest percentage of students eligible for free or reduced-price lunch.

123. To be clear, a student can get one of the Kahlenberg Bumps, two of them, or all three of them.[113] Thus, a student who, prior to the addition of the Kahlenberg Bumps, would have had an estimated admissions probability of 21.2 percent based on Model 4 in the 2014–15 admissions cycle (the median admission probability for an in-state applicant in Kahlenberg's Simulation 1 prior to the addition of the Kahlenberg Bumps) would have that probability rise to 97.6 percent if she got only one bump, rise to 99.98 percent if she got two bumps, and rise to 99.999 percent if she got all three bumps. In other words, the median applicant could have as much as approximately 76 percentage points added to her estimated admissions probability due to just one bump.[114]

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[112] The KA simulations generate admissions probabilities for each applicant by applying a Logit transformation to an index that depends on the applicant's characteristics. It is this index that the Kahlenberg Bumps directly adjust – the size of the impact on the resulting admission probability depends on the applicant's value of the index prior to receiving the bump.

[113] In KA Simulation 2, Mr. Kahlenberg incorporates Bump A, in KA Simulation 3, he incorporates Bumps A and B, and in KA Simulation 4 he incorporates Bumps A, B, and C.

[114] For the set of students used in Prof. Arcidiacono's estimation of his Model 4, the median increase among the 2,519 applicants eligible for one bump would be 6.3 percentage points, among the 1,113 applicants eligible for two bumps would be 34.5 percentage points, and among the 257 applicants eligible for all three bumps, 55.36 percentage points.

1. The KA Simulations Apply Prof. Arcidiacono's Estimated Admissions Models Solely to Past UNC Applicants, Not Students Who Are Representative of the Students Who Would be Affected by UNC's Adoption of a Particular Race-Blind Alternative Admissions Plan

124. Mr. Kahlenberg applies this procedure only to past UNC applicants, essentially multiplying each past applicant by her or his estimated admissions probability once race is ostensibly removed from the process and after the Kahlenberg Bumps are added. This multiplication produces a predicted UNC class that is too large, so the KA simulations rescale all the multipliers until they get a class that corresponds to the approximate size of the class UNC typically admits.[115] These rescaled results are shown in the Kahlenberg Report.[116]

125. Mr. Kahlenberg presents the KA simulations as reliable predictions of what would occur if his proposed socioeconomic admissions plans were implemented. But Mr. Kahlenberg glosses over his decision to model this hypothetical admissions plan on only the pool of actual UNC applicants rather than the larger pool of students who might apply if UNC were to change its admissions plan, for example those North Carolina public school students who are reflected in the available NCERDC data. Indeed, he only discusses the decision to apply the procedure to past applicants in footnote 292, and in that footnote he speculates (without any accompanying analysis) that the predictions will be reliable.

2. To Assess the Validity and Reliability of the KA Simulations, I Apply the KA Simulation Procedure to North Carolina Public School Students Who Would Be Affected by Any Alternative Admissions Plan

126. I have already discussed the underlying reasons why applying the Arcidiacono Models and KA simulation procedure only to past applicants will produce unreliable results, but this unreliability can also be seen by applying the available data. In particular, it is instructive to apply the KA simulation procedure to most prospective UNC applicants (i.e. North Carolina public school students) and not just past applicants.

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[115] After applying Kahlenberg Bumps, zeroing out other variables, and "transforming" all applicants to be white, the estimated intercept is adjusted until the mean probability of admission is within 0.01 percent of the mean probability of admission for all students before the bumps and transformation were applied.

[116] Kahlenberg Report, p. 70.

127. To assess the validity and reliability of the KA simulations, I apply the KA simulation procedure to North Carolina public school students as represented in the NCERDC data. Not only would these students make up the bulk (approximately 80 percent of in-state applicants) of the students who would be affected by *any* alternative admissions plan at UNC, many alternative admissions plans could not plausibly be implemented with out-of-state students, private school students, and home-schooled students.[117]

128. Specifically, I apply the KA simulation procedure as follows:

i. I use Prof. Arcidiacono's Model 2 based on past in-state UNC applicants because this model presents the fewest of the problems I identified in Prof. Arcidiacono's models above.[118]

ii. I follow the KA simulation in making the Arcidiacono Model race-blind by setting the estimated coefficients on all of the race variables to "white."[119]

iii. I apply Kahlenberg Bumps (Bump A and/or Bump B) exactly as done in KA Simulation 3 and as described above.[120, 121]

iv. I apply this procedure to the NCERDC data. Then, like in the KA simulations, I can rescale the estimates to get a class of about the right size. I show the estimates before and after rescaling.[122]

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[117] See Hoxby Report, ¶¶ 258–268.

[118] In order to be able to apply Prof. Arcidiacono's Model 2 to students in the NCERDC data, I needed to remove the variables in the model for which there is no analogue in the NCERDC data: alum, decision round (Early vs. Regular decision), class rank type, and athlete. I also adjust the race/ethnicity categories to the categories used in the NCERDC data. I re-estimated Prof. Arcidiacono's Model 2 without these variables and the resulting coefficients and provided in the backup materials to this report. The R-squared of the model changed from 0.565 to 0.524 due to the removal of these variables.

[119] As I explain in Section V.A.1 above, the KA simulations are not truly race-blind, because Mr. Kahlenberg and Prof. Arcidiacono do not set coefficients on all race interaction variables equal to "white." In my analysis I correct for this to make the simulations actually race-blind by setting the coefficients on all race interaction variables equal to "white" or the same race.

[120] Simulation 3 is the simulation reported by Mr. Kahlenberg in the text of his report. Kahlenberg Report, Section IV.A.

[121] The NCERDC data do not contain information on whether a student would be a "first generation college" (FGC) student or whether the student would be eligible for a fee waiver if he or she were to apply to UNC. Therefore, I estimate the probability that each student would be FGC or eligible for a fee waiver based on the following characteristics: student-to-teacher ratio, percent of free lunch receivers, percent of reduced-price lunch receivers, household median income, household mean income, family median income, family mean income, percent of 25+ year old population in each education attainment group, mean education attainment for 25+ year olds, size of 12th grade class, percent of families headed by single parents, mean number of dependents in each household, indicators for each geographical location category (based on urban/rural characteristics). If a student has a probability of at least 50 percent of being FGC or of being eligible for a fee waiver, or is categorized as economically disadvantaged, I give that student the Kahlenberg Bump A.

[122] In Exhibit 6, I focus on one admissions cycle (2014-15). In other admissions cycles, the overall conclusions are the same. I provide these results in my backup materials.

129. I show the results of this assessment in **Exhibit 6** which can be compared to the KA simulation (Simulation 3) shown in Table C.1a in the Kahlenberg Report.[123] Exhibit 6 has three columns. The left-most columns show statistics on UNC's current in-state admits (what Mr. Kahlenberg calls the "status quo," narrowed down to public school students). The middle columns show the class that UNC would likely admit based on applying the KA simulation procedure to North Carolina public school students. In this middle set of columns, UNC's admitted class is too large—an artifact of the KA simulation procedure applied to all North Carolina public school students. The right-most columns scale the admitted class to about the right size using the method proposed by Prof. Arcidiacono to account for "capacity constraints."[124]

Exhibit 6[125]
KA Simulation 3 (Socioeconomic Status-Based Plan)
Using Arcidiacono Model 2 and NCERDC Data
2014-15 Admissions Cycle

	Status Quo (Actual UNC Resident Public School Admits) [3]			Kahlenberg/Arcidiacono Simulation 3 Applied to NCERDC [4]			Kahlenberg/Arcidiacono Simulation 3 Applied to NCERDC and Scaled [5]		
Race/Ethnicity [6]	Total Admits	Avg. SAT Score [7]	Avg. GPA [8]	Total Admits	Avg. SAT Score [7]	Avg. GPA [8]	Total Admits	Avg. SAT Score [7]	Avg. GPA [8]
African American	293	1196	4.57	8,322	878	4.09	665	1028	4.56
Asian	401	1349	4.78	1,276	1158	4.68	164	1215	4.87
Hispanic	204	1235	4.62	3,233	957	4.18	324	1090	4.62
Native American	65	1256	4.62	899	862	4.19	102	1020	4.60
Pacific Islander	4	1266	4.91	41	1060	4.28	5	1186	4.54
White	2,360	1316	4.75	17,707	1092	4.46	2,081	1166	4.69
Missing	124	1350	4.77	17	870	2.82	1	928	2.82
Multi-racial	-	-	-	1,035	1025	4.33	100	1128	4.64
Total	**3,451**	**1305**	**4.73**	**32,529**	**1025**	**4.40**	**3,442**	**1136**	**4.69**

130. The table shows that UNC's admitted class would have substantially lower SAT scores and grades under Mr. Kahlenberg's socioeconomic admissions plan. Comparing the middle columns to the left columns, the average SAT scores of most racial/ethnic groups would fall by about 200 points or more. For instance, the average SAT scores of African American admits would fall from 1196 to 878. The average SAT scores of Hispanic admits would fall from 1235 to 957. White admits' average SAT scores would fall from 1316 to 1092. These declines in

[123] KA Simulation 3 uses Arcidiacono Model 4 to generate its predictions. However, because Arcidiacono Model 4 relies on the endogenous ratings variables that are not available for the full set of prospective UNC applicants, I instead use Arcidiacono Model 2 for this comparison. I conduct these simulations using Prof. Arcidiacono's Model 2 in order to parallel the KA simulations and to address the conclusions that Mr. Kahlenberg draws based on them; however, for the reasons given throughout this report, I do not consider the Arcidiacono Models reliable.
[124] In Exhibit 6, I have adopted Prof. Arcidiacono's proposed method of adjusting the admitted class to account for "capacity constraints." (Arcidiacono Report, p. 52) I note, however, that the econometrically preferable way to account for a capacity constraint would be to impose that constraint during the estimation of the model, which Prof. Arcidiacono has not done.
[125] See Exhibit 6 for sources and notes.

academic preparation would be so large as to imperil UNC's ability to fulfil its educational mission.[126]

131. Exhibit 6 shows that when KA Simulation 3 is applied to North Carolina public school students, the average GPA would fall (relative to the results reported by Mr. Kahlenberg) by approximately 0.1 to 0.5 GPA points, depending on the racial/ethnic group, in the middle columns compared to the left columns. Therefore, even on the dimension of GPA, which is not as objective of a measure as SAT scores, the results of KA Simulation 3 would differ from those reported in the Kahlenberg Report when the simulation is applied to the set of students from which most UNC applicants are drawn.

132. Although Exhibit 6 shows both the class that UNC would likely admit based on applying the KA simulation procedure to North Carolina public school students (the middle columns) and the admitted class scaled to about the right size using the method proposed by Prof. Arcidiacono (the right columns), it is appropriate to focus on the unscaled results (the middle columns) when analyzing the KA simulation. The reason is that Prof. Arcidiacono's method of rescaling is ad hoc and does not apply capacity constraints in a manner that is accepted in the literature on discrete choice modeling. If Prof. Arcidiacono had accounted for "capacity constraints" in the estimation of his model, his predictions would not need this problematic ex post rescaling. The fact that his rescaling methodology has strong effects on the predictions indicates that his methodology is not well-suited for counterfactual exercises.

133. By not accounting for how the applicant pool would change under his socioeconomic status-based admissions plans, Mr. Kahlenberg has misrepresented the admitted class that would result from adopting his approach to admissions. If one applies his socioeconomic status-based plan to the majority of prospective applicants to UNC, namely North Carolina public high school students, the resulting admitted class would have much lower test scores, meaning that Mr. Kahlenberg has not shown that this plan is a workable race-blind alternative that would allow UNC to maintain its academic standards.

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[126] As I discussed in Section IV.C of my opening report, it is reasonable to assess the magnitude of losses to the university's mission by considering how the average statistics, such as the average test scores, of UNC's student body change under each alternative admissions plan. While UNC, which practices holistic admissions, admits individual students who thrive despite having lower test scores, a university whose student body had lower average test scores would usually be unable to maintain a world-class educational environment. This is because the characteristics of an individual have a different meaning than average statistics computed over a large number of individuals. See Hoxby Report, ¶¶ 117–122 for further discussion.

3. In Summary, There Are Three Main Reasons Why the KA Simulations Generate Predictions that are Invalid and Unreliable

134. Mr. Kahlenberg's opinions are based on the KA socioeconomic status-based simulations being applied to the wrong set of students (UNC past applicants rather than prospective applicants). There are at least three reasons why this application generates invalid and unreliable predictions:

i. The Kahlenberg Bumps for socioeconomic criteria are *very large* relative to the improvements in admissions probabilities associated with other criteria such as test scores, grades, and higher class rank. The bumps are also broad, meaning they apply to a large number of students. (These facts are made even clearer by the evidence I present in the next section.) Because the bumps are very large and apply to many students, even a modest response to the bumps would change UNC's admissions pool enough to greatly alter the predictions of the KA simulation procedure.

ii. It is illogical to assume that if a student's probability of admission were greatly raised by his receiving one to three big "bumps," his probability of applying would be unchanged. Keep in mind that the Kahlenberg Bumps would be known to families long before it was time for their child to apply. (For instance, a family knows whether its child is eligible for the free or reduced-price lunch program. A family could easily determine whether its high school or zip code met the socioeconomic criteria.)

iii. It is *contrary to the evidence* to assume that if a student's probability of admission is greatly raised, he or she will be no more likely to apply. Evidence from Texas, Florida, California, and other states that adopted revised admissions plans indicates that students who were favored (in terms of admissions probabilities) by the new plans were more likely to apply. Students who were disfavored by the new plans were less likely to apply.[127]

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[127] See Long Report, Section VI.C.

135. Given these points, it is likely that the set of students who apply to UNC would change if UNC were to implement the socioeconomic status-based plans Mr. Kahlenberg described. If it were to do so, the resulting admitted class would have different characteristics (including lower test scores) than those shown in the Kahlenberg Report.

B. The "Kahlenberg Bumps" Are So Large and Apply to So Many Prospective Applicants that They Would Generate a Student Body that Is Academically Less Qualified

136. As I discussed above, I do not disagree that a way to model a socioeconomic status-based admissions plan is to give greater weight to socioeconomic factors. Where I disagree with the KA simulations in this respect is how *much* weight they give to socioeconomic factors. Above, I explain that based on the Kahlenberg Bumps, an applicant may receive an additional 5 to 15 index points that would increase the median applicant's admissions probability by as much as 79 percentage points. But what does a 5 to 15 point increase in a student's estimated admissions index really mean?[128] To aid in understanding the impact of the Kahlenberg Bumps on the UNC admissions process and how substantial they really are, I translate the preference that Mr. Kahlenberg gives to these socioeconomic indicators. As I show below, the preference is tremendous.

137. A first indication that the bumps are very large is the degree to which they would change UNC's class, were they used in the alternative admissions process proposed by Mr. Kahlenberg. In the previous section, I showed that the bumps would result in large changes in the composition of UNC's admitted class if one were to apply the KA simulation to the pool of prospective North Carolina public school applicants.

138. In this section, I show a second way to understand the size of the bumps: (1) I translate them into points on the SAT, GPA points, or class rank percentile (all within Prof. Arcidiacono's models) and (2) I show that they would apply to a large number of North Carolina students. It is the combination of the outsized magnitude of the Kahlenberg Bumps and the large number of students eligible for them that makes the KA simulations artificial and extremely unreliable.

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[128] Interpreting the magnitude of the Kahlenberg Bumps is complicated by the fact that these are not 5 to 15 point increases in some index that would determine a student's actual probability of admission. Rather, they are only increases in the estimated admission index generated by Prof. Arcidiacono's admissions models, and his models capture the UNC admissions process only very partially.

Even small changes in the applicant pool would invalidate all of the predictions from the KA simulations.

1. The Kahlenberg Bumps Are Equivalent to Extremely Large Changes in SAT, GPA, or Class Rank

139. I show just how large the Kahlenberg Bumps are in the context of Prof. Arcidiacono's models by comparing them to the Arcidiacono-estimated impact of other characteristics of a student – namely, SAT, GPA, and class rank. If a student has one Kahlenberg Bump, it increases his estimated probability of admission by increasing the Arcidiacono-estimated index by 5 points. How much would the student's SAT scores have to rise to give him the same increase in his estimated probability of admission, in the Arcidiacono model? What if a student has two or three Kahlenberg Bumps? **Exhibit 7** shows the translation of Kahlenberg Bumps into improvements in SAT scores. In each row, the bump and the improvement in SAT scores generate the same increase in a student's admissions probability. Note that I am using Prof. Arcidiacono's *own* model throughout.[129]

Exhibit 7[130]
SAT Score Increase Equivalent to Kahlenberg Bumps
2014-15 Admissions Cycle

Number of Kahlenberg Bumps [3]	Equivalent Increase in SAT Score (Combined Math and Verbal) [4]
1 bump (A, B, or C)	278
2 bumps (A + B, A + C, or B + C)	556
3 (all) bumps (A + B + C)	834

140. Even a single Kahlenberg Bump is worth a great many SAT points: 278. For instance, this would change a student with a score of 1000, who would ordinarily not have much chance of admission, into a student with a score of 1278, well into UNC's normal admit range. A student

[129] In Arcidiacono Model 4 for in-state applicants in the 2014-15 admissions cycle, the coefficient on standardized SAT math is 1.42 (rounded) and the coefficient on standardized SAT verbal is 1.53 (rounded). Therefore, an increase of 5 index points (one bump), if it were to be achieved half through the SAT math score and half through the SAT verbal score, could be achieved by increasing the standardized SAT math by 1.76 (rounded) and the standardized SAT verbal by 1.63 (rounded). Because the standard deviation of Prof. Arcidiacono's SAT math variable is 85.3 points and the standard deviation of Prof. Arcidiacono's SAT verbal variable is 78 points, the bump-equivalent increases in the standardized scores correspond to increases in raw SAT scores of 150 SAT math points and 128 SAT verbal points. Combining these gives 278 total SAT points corresponding to one bump. The SAT score equivalents of two or three bumps are calculated analogously.

[130] *See*, Exhibit 7 for sources and notes.

who received three Kahlenberg Bumps could have a score of 600 (just the 2nd percentile—almost the bottom—of the SAT distribution and well below the score of any UNC admit observed in the data) and be treated in admission like a student with a score of 1434 (quite high up in UNC's normal admit range). The Kahlenberg Bumps are, simply put, extremely large in magnitude.

141. Translating the Kahlenberg Bump into GPA points (where A=4, B=3, etc.) shows even more dramatic results. In fact, the Kahlenberg Bumps are so large that they are equivalent to impossibly large increases in GPA. For example, just one Kahlenberg Bump is equivalent to 4.41 GPA points, which is essentially impossible to achieve (GPA points usually range from 1 to 5).

142. Similarly, the Kahlenberg Bump is equivalent to an improbably large increase in class rank on a percentile scale (where the highest-ranked student is at the 99th percentile and the lowest-ranked student is at the 1st percentile). Just one Kahlenberg Bump results in a larger increase in the probability of admission than a change in class rank percentile from the 20th percentile to the 91st percentile.

143. If UNC were to follow Mr. Kahlenberg's proposal and admit students using the Kahlenberg Bumps or other bumps giving similar weight to socioeconomic status, UNC's admissions would fundamentally change. In particular, the outsized weight given to socioeconomic bumps would effectively convert much of the university's admissions process from a holistic process into a formula based on Kahlenberg Bumps (or similar bumps), for many applicants. That formula would effectively preclude UNC from considering many of the factors that it currently considers on a holistic basis as part of determining which applicants would be a good fit for UNC. That is, the Kahlenberg Bumps would essentially imply that UNC would need to admit students who are not well-qualified on other dimensions.

2. The Kahlenberg Bumps Would Apply to a Large Number of North Carolina High School Students

144. The Kahlenberg Bumps are not only extremely large (for each student who receives one or more of them), they also apply to numerous students. **Exhibit 8** shows how many students in the NCERDC data would be eligible for Kahlenberg Bumps.

Exhibit 8[131]
Number of URM and Non-URM North Carolina Public School Students Eligible for Kahlenberg Bumps
2014-15 Admissions Cycle

Number of Kahlenberg Bumps for Which Student is Eligible [2]	Number of URM Students [3]	Number of Non-URM Students [3]
0 bumps	3,937	21,030
1 bump or more (A, B, C or combination)	35,247	35,979
2 bumps or more (A + B, A + C, B + C, or A + B + C)	21,327	18,349

145. The table shows that *tens of thousands* of North Carolina public school students would receive one or more Kahlenberg Bumps, were they to apply to UNC. 35,247 URM students would be eligible for one or more Kahlenberg Bumps, were they to apply. 35,979 non-URM students would be eligible for one or more Kahlenberg Bumps.

146. Now, most of these 71,226 Bump-eligible students are not at all well-qualified for admission at UNC. If we classify them using Prof. Arcidiacono's and Mr. Kahlenberg's *own* methodology for Simulation 3, they would have low probabilities of admission. But, with the Kahlenberg Bumps, their admissions probabilities increase greatly. For instance, of the students in the NCERDC population eligible for Kahlenberg Bumps A or B in KA Simulation 3, 31 percent would have had less than 5 percent admissions probability according to Prof. Arcidiacono's Model 2, but with the Kahlenberg Bumps would have over 50 percent probability of admission. It is not plausible that if UNC's admissions process were to raise so many students' admissions probability from under 5 percent to over 50 percent, its pool of applicants would remain unchanged.[132]

3. The Kahlenberg Bump Is Not Justified by the Comparison to "Legacy Preferences"

147. It is worthwhile addressing Mr. Kahlenberg's claim that one of his bumps is equivalent to the increase in admissions probability that Prof. Arcidiacono estimates for children of out-of-

[131] *See*, Exhibit 8 for sources and notes.
[132] The 5 percent admissions probability is calculated according to KA Simulation 1, where Arcidiacono Model 2 has been applied to the NCERDC population, as set out in Exhibit 6. Note that all of these estimated admissions probabilities are based on the Arcidiacono Models, which I do not consider to be reliable.

state alumni.[133] (Keep in mind, however, that under the reasoning of the KA simulations, a student can receive *three* bumps whereas no student could possibly be the child of an out-of-state alum *three times over*.) This claim by Mr. Kahlenberg may seem reasonable at first glance, but it is really an artifact of Prof. Arcidiacono's model being overfit and seizing on a strong interpretation of an estimated coefficient that applies to very few students.[134] To see this, consider that one Kahlenberg Bump is approximately *ten times* the increase in admissions index value that Arcidiacono Models 2 and 4 estimate for children of *in-state* alumni.[135] In addition, the number of out-of-state applicants who are children of alumni is only two-fifths the number of in-state applicants who are children of alumni. In fact, seizing on the estimated coefficient for out-of-state alumni children is hardly different than seizing on some other small group of students—students who could be soloists in the orchestra, say—estimating a coefficient for them in an overfitted model and then using that estimate as a "yardstick" for the effect of any other student characteristic. The orchestra-based estimate would apply to so few students that it would be a prime candidate for overfitting and over-interpretation (as with any other highly selected, small subset of students whose admissions decision might turn on a peculiar factor). Thus, when used as a "yardstick" for a bump applied to many students, the orchestra-based estimate might produce outsized effects that would not make sense as part of a holistic admissions process. Mr. Kahlenberg may be using out-of-state alumni rather than the orchestral instrumentalists, but the principle is the same. For judging magnitudes, the yardstick needs to be a student characteristic that is reasonably common among applicants—test scores, grades, class rank, etc.

148. To summarize, Mr. Kahlenberg's preferences for certain socioeconomic variables (Kahlenberg Bumps) are arbitrarily large. The KA simulation predictions, being based only on past UNC applicants are not, in any case, reliable. If implemented in an admissions process with most prospective applicants, the Kahlenberg Bumps:

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[133] Kahlenberg Report, p. 68.

[134] In Prof. Arcidiacono's models, each applicant characteristic in the model has an associated coefficient that Prof. Arcidiacono estimates, which is meant to capture the extent to which that characteristic is associated with UNC admission, conditional on the other applicant characteristics included in the model. In this section, I discuss the estimated coefficients from the Arcidiacono Models, but I do not agree that they accurately capture how UNC admissions decisions would change if one were to change one of the characteristics in his models.

[135] The estimate of alumni preference for in-state applicants described here is based on Arcidiacono's Models 2 and 4, which I do not consider to accurately or reliably capture UNC's admissions process.

- would fundamentally change the nature of UNC's admissions to make it a process that was much less holistic; and
- would greatly reduce the academic preparedness of the class.

C. Mr. Kahlenberg's Version of a "Percentage Plan" Is Unworkable and Does Not Correspond to Top X Percent Plans that Are Implemented, Not Even in Spirit

149. Now that I have addressed why the KA socioeconomic status-based simulations are unreliable and do not show that UNC has a workable socioeconomic status-based alternative available, I turn to the other specific alternative proposed by Mr. Kahlenberg. In his Simulation 5, Mr. Kahlenberg suggests that UNC employ a plan that selects "the top 4.5% of students in every North Carolina high school who rank highest using UNC's current holistic model."[136] I call this the "Kahlenberg Top" plan. Mr. Kahlenberg's proposed version of a "Percentage Plan" does not correspond, even in spirit, to the approach used by all other Top X Percent plans adopted in U.S. states.[137]

150. As I describe in this section, it is unlikely that the necessary conditions for implementing Mr. Kahlenberg's unusual plan could be achieved. In my opening report, I also analyzed Top X Percent plans, but my analysis was based on a more realistic and straightforward implementation of the Top X Percent plans, as they have been implemented in other states.[138] The fact that Mr. Kahlenberg gets substantially different results from those in my opening report is due to the peculiar way in which his hypothetical Top X Percent plan would work, which is unlike any other percentage plan that I am aware has ever been adopted or studied.

151. Specifically, the "Kahlenberg Top" plan works as follows:

i. Mr. Kahlenberg assumes that, somehow, the applicants who are induced to apply under the "Kahlenberg Top" plan are just like those (in terms of their qualifications, high schools, etc.) who currently apply under UNC's current admission policy. It is *crucial* to the Kahlenberg Top plan that no applicants newly made eligible by their class rank apply.

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[136] Kahlenberg Report, p. 76.
[137] *See*, Long Report, Section VI.B and references therein.
[138] Hoxby Report, Section VI.

ii. UNC "ranks" applicants using Arcidiacono Model 4.[139] I note that this is not how UNC actually conducts its admissions process.

iii. UNC reserves a number of seats per North Carolina high school that is equal to 4.5 percent of that high school's graduating class.

iv. UNC takes each high school's applicants in order of their Model 4 prediction and admits them in that order until it hits the reserved number of seats for that high school. If there are extra seats, they go unfilled. If there are more applicants than seats, then those with lower Model 4 predictions are rejected.

152. To understand how unrealistic the Kahlenberg Top plan is, it is worthwhile comparing it with a Top X Percent plan that has actually been implemented. To make the comparison clear, I will focus on two hypothetical types of high schools and show how their students fare under an actual Top X Percent plan and under the Kahlenberg Top plan.

153. School A is a high school with high academic standards where a student who is a very well qualified UNC applicant based on his test scores, extracurriculars, and other characteristics may nevertheless have a class rank outside the top several percentiles—simply because he is competing for that rank with so many other well qualified students. (A selective magnet school would be an obvious example of an A-type school but so would numerous other schools that serve families who seek a challenging academic environment for their children.)

154. School B is a high school with low academic standards in general so that a student from there who is a reasonably likely candidate for UNC admission *under the current system* has anomalously high test scores or other qualifications *for someone from his high school*. That is, the students who currently apply to UNC from B-type schools tend to be students who stand out from their classmates on the basis of test scores, extracurricular activities, or some other qualification. Of course, these stand-out students from B-type schools are likely to be very highly ranked in their class as well, but that is not what makes them solid admissions candidates under the current system. They have classmates whose class ranking is also high but who—because of the school's lower academic standards overall—have test scores or other

[139] In Kahlenberg's Top plan, he includes an athlete "preference." Kahlenberg Report, p.77.

qualifications that would make them unlikely to be admitted to UNC under its current admissions approach.

155. There are of course high schools that fall between the A-type and B-type schools, but one can think through a Top X Percent plan with just the A-type and B-type schools.

156. Now suppose that UNC implemented a standard Top 4.5 Percent plan where all students ranked in the top 4.5 percent of their class would automatically qualify for UNC admission. What would occur? Students from the A-type schools who were in the top 4.5 percent would continue to apply. Many of them would have been in the applicant pool in any case (i.e. under the old system) since a top ranked student from an A-type school would typically have high test scores and other strong qualifications.[140]

157. Under the standard Top 4.5 Percent plan, the students from the B-type school who have applied under the old system would still apply because, recall, in order to be likely admits under the old system they had to have standout qualifications among their classmates (so that they were nearly guaranteed to be top ranked). *However*, a new group of students from B-type schools would apply under the Top 4.5 Percent plan who would not have applied under the old system, and attracting these students is the whole point of a Top X percent plan. These new students would be those who ranked in the top 4.5 percent of their class (and were eligible for automatic admission) but whose test scores or other qualifications would have made them very unlikely admits under the old UNC system.

158. Thus, what happens under a standard Top X Percent system? Fewer students from A-type schools are admitted, but they tend still to be well-qualified (but quite possibly worse on holistic grounds).[141] The standout students from B-type schools who were admitted under the old system are still admitted. But a new type of student from B-type schools is admitted and these students have lower test scores and qualifications (other than class rank).

159. In terms of student demographics, a standard Top X Percent system has to be evaluated on a case-specific basis. For instance, if the top-scoring African American students in a state tend to be enrolled in A-type schools but have class rank outside the top few percentiles, then the

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[140] Students from the A-type schools who were outside the top 4.5 percent may not apply to UNC but would instead apply to other selective colleges.

[141] Strictly speaking, the fewer students from A-type schools will be worse on holistic grounds than if the University were to admit the same number of students from A-type schools through a holistic process.

plan will tend to reduce African American representation from the A-type schools but some of this loss will typically be counteracted by gains in African American representation from B-type schools (although potentially with a substantial decrease in African American students' average test scores and other academic qualifications). I evaluated standard Top X Percent plans for North Carolina in my opening report. The aforementioned trade-offs appear in my analysis in that report.[142]

160. Now consider the Kahlenberg Top plan. What would occur if it were implemented? Under the Kahlenberg Top plan, Mr. Kahlenberg assumes that the same students from A-type schools apply. From each A-type school, the University initially admits some top percentage of its class (think of 3 percent, initially) where students are ranked on Model 4 predictions. Since, relative to UNC's true holistic process, Model 4 overweights test scores, grades, and other readily observed academic qualifications, the students from A-type schools admitted at this point will have higher test scores and grades than the students UNC would have admitted from A-type schools under its current admissions system.

161. Turning now to the B-type schools, Mr. Kahlenberg *crucially* assumes that the only students who apply are the students who would have applied under the old system as well—these tend to be the standout students. In other words, Mr. Kahlenberg inexplicably does not account for the change in the applicant pool from B-type schools that would be certain to occur if UNC (hypothetically) adopted the Kahlenberg Top plan. Since the standout students *necessarily* make up a smaller share of their B-type high school classes than do students with the same test scores and grades from A-type schools, the University is likely to run out of applicants from B-type schools and be left with empty seats from B-type schools even at some initial X percentage like 3 percent. Moreover, *for any value of X*, the University will always run out of applicants from B-type schools *first*.

162. So, having taken X (perhaps 3) percent of students from each high school, still holding seats because there are left-overs from the B-type schools, then the University will make its percentage take more generous—for example, taking up to 4.5 percent from each school rather than 3 percent. But, the University will have already run out of applicants from B-type schools

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[142] *See*, Hoxby Report, Section VI.

so these schools are irrelevant to the remainder of the process. Under Kahlenberg's simulations, the University will keep admitting students from A-type schools until it fills the class.

163. Thus, because Arcidiacono's Model 4 overweights test scores and grades and other observable qualifications relative to the UNC holistic process, the Kahlenberg Top model can produce a hypothetical student body with test scores and grades that are as high or higher than the status quo *so long as the Kahlenberg Top model is applied only to the previous UNC applicant pool*.[143] It is *only* by excluding the possibility of any new applicants from B-type high schools that the Kahlenberg Top model achieves this result.

164. This point is worth emphasizing. In numerous instances, I critique Prof. Arcidiacono and Mr. Kahlenberg for limiting their analysis to the pool of past UNC applicants rather than potential applicants. My criticism of the Kahlenberg Top plan, however, is broader than this concern. To achieve "successful" results (according to Mr. Kahlenberg), the Kahlenberg Top plan would require that new students from B-type high schools do *not* apply. UNC cannot control who does or does not apply. It also defies common sense to suggest that UNC would somehow not announce that it was implementing an entirely new race-blind admissions program and that the applicant pool would not change as a result.

165. Indeed, as the available research shows, the Top X Percent plans that have actually been implemented, like that of Texas, actually *do* attract new students from B-type high schools.[144] So, if North Carolina were to take the Kahlenberg Top plan, as proposed, and try to implement it, the available research indicates that it would not get the results described by Mr. Kahlenberg. Thus, Mr. Kahlenberg's assumption of no new applicants from B-type high schools defies both common sense and the experience of schools that have implemented race-blind admissions.

166. In my opinion, the conditions for implementing the Kahlenberg Top plan would be impractical and contrary to the spirit of a standard college admissions plan. Since the predictions shown in the Kahlenberg Report for the Kahlenberg Top plan *depend on there being no new applicants*, it is my opinion that those predictions are unrealistic and unreliable.

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[143] When applied to the previous UNC applicant pool, the Kahlenberg Top model may also admits some applicants from B-type schools who were not likely to be admitted under UNC's actual holistic admissions process but who did actually apply and are in the previous UNC applicant pool (these students are admitted under the Kahlenberg Top plan because it sets aside more seats for the B-type schools than there were actual applicants, so these applicants are admitted regardless of their qualifications). This aspect of the plan will tend to reduce the average test scores in the Kahlenberg Top plan's admitted class relative to the status quo.

[144] *See*, Long Report, Section VI.C.

167. Further, it is my opinion that the evaluations of standard Top X Percent plans that are shown in my affirmative report do generate reliable predictions of how such plans would affect UNC. Not only do I evaluate Top X Percent plans that resemble other actual plans, I also employ a range of reasonable assumptions about the share of newly-admissions-eligible students who would apply were a Top X Percent plan put in place.[145]

168. Although I do not think that the predictions for the Kahlenberg Top plan discussed in the Kahlenberg Report (pp. 76–79) are reliable, I do note the following additional problems with those predictions.

i. The average characteristics, including test scores and GPA, of the admitted students in the KA simulation of Mr. Kahlenberg's Top 4.5 Percent Plan (reported on page 78 of the Kahlenberg Report) are calculated incorrectly. As I described above, his procedure would assign a particular number of admission slots to each school and in his simulation, he "fills" these slots with actual past UNC applicants. That is, in this simulation, applicants are either admitted or they are not. However, in the KA simulation, average SAT and GPA are *weighted* such that applicants with a higher probability of admission under Arcidiacono Model 4 receive a larger weight in the average. There is no justification for this and it means that the average statistics reported for his Simulation 5 are incorrect. **Exhibit 9** shows the results of KA Simulation 5 when the average SAT is calculated correctly: the average SAT of admitted applicants would be 1246, rather than the 1320 he reported. Mr. Kahlenberg incorrectly overstated the average SAT of the admitted class by 74 points.[146]

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[145] Hoxby Report, ¶ 227.

[146] Note that these numbers are based on KA Simulation 5, which in turn is based on the Arcidiacono Models. Exhibit 9 reports numbers based on these models for comparison with the Kahlenberg Report, but should not be taken to mean that I endorse this simulation methodology or the Arcidiacono admissions model.

Exhibit 9[147]
KA Simulation 5: Top 4.5 Percent Model, with Average SAT Score Calculated Correctly
2014-15 Admissions Cycle

	Status Quo: Actual UNC Admitted Class [3]		Kahlenberg Report Results [4]		Kahlenberg Report Results, but Without Adm. Prob. Weighting on Test Scores [5]
Race/Ethnicity	Total Admits	Avg. SAT Score	Total Admits	Avg. SAT Score	Avg. SAT Score
African American	383 (9%)	1195	491 (13%)	1216	1098
Asian	488 (11%)	1354	423 (11%)	1359	1294
Hispanic	241 (5%)	1238	237 (6%)	1272	1189
Native American	74 (2%)	1261	49 (1%)	1298	1214
Pacific Islander	7 (0%)	1284	5 (0%)	1270	1239
White	3,064 (69%)	1320	2,419 (65%)	1323	1271
Missing	170 (4%)	1358	117 (3%)	1352	1310
Total	**4,427 (100%)**	**1309**	**3,741 (100%)**	**1320**	**1246**

ii. Mr. Kahlenberg's presentation of the predictions (Simulation 5 on page 78) is misleading. While he says that he simulates a "top 4.5% model" using UNC's past applicants, this cutoff is in fact too low to create an in-state admitted class that is comparable in size to the in-state "Status Quo" admitted class. It is misleading to compare a "Status Quo" class of 4,427 students with an alternative class of 3,741 students and declare that "Simulation 5 is superior to the status quo in virtually every respect."[148]

iii. In forming his predictions (Simulation 5), Mr. Kahlenberg uses the incorrect variable to identify high schools. Specifically, he identifies high schools using the NCERDC variable known as "SCHLCODE."[149] This variable is not, in fact, a code for a unique high school. Instead, in order to identify a high school, the variable SCHLCODE must be combined with the appropriate district (LEA) code.[150] The effect of this error is that Mr. Kahlenberg identifies too few students as attending high schools with small class sizes. This biases his estimates of the effects of his Simulation 5.

iv. Mr. Kahlenberg has not explained how his "Percentage Plan" could be applied to high schools with small classes or to home-schooled students. Many private schools in

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[147] See Exhibit 9 for sources and notes.
[148] Kahlenberg Report, p. 78. Although Mr. Kahlenberg claims that he is following the approach of UNC in selecting the "top 4.5%" because "UNC determined in its own simulations that a 'top 4.5%' model would yield a class similar in size to the current student body" (Kahlenberg Report, p. 76), Mr. Kahlenberg does not acknowledge that this choice results in the KA Simulations comparing admitted classes of different sizes.
[149] He ranks students within SCHLCODEs using Arcidiacono Model 4 (which includes UNC's ratings variable).
[150] My opening report correctly identifies high schools using the College Board ATP code.

North Carolina have too few students for any plan based on a "Top" percentage of students from that high school. For example, as it is implemented in the KA Simulations, the Kahlenberg Top plan would never admit any student from a high school graduating class of less than 23 students.

v. Mr. Kahlenberg further speculates that "a version of the percentage plan could also be applied to out-of-state applicants by admitting top students from a variety of geographic locations, such as zip codes or College Board clusters."[151] He does not analyze or test this claim in any way. There are in excess of 42,000 5-digit ZIP codes in the United States and millions of ZIP+4 codes,[152] so what a "workable" out-of-state percentage plan might look like needs to be explained (and not just asserted) with much greater specificity. The College Board collapses geographic neighborhoods into 33 neighborhood clusters for the purposes of helping educational institutions better target recruitment.[153] Similarly, Mr. Kahlenberg has not specified how these cluster groupings might be used for an "out-of-state Top Percent plan."

D. Numerous Suggestions Made by Mr. Kahlenberg Regarding Alternative Admissions Plans are Unfounded, Unworkable, or Based Purely on Hopes

169. Numerous suggestions made by Mr. Kahlenberg regarding alternative admissions plans are unfounded or unworkable. In multiple cases, he suggests plans that he hopes might work without assessing the practicalities involved or the evidentiary basis for his hopes.

170. For instance, Mr. Kahlenberg suggests that one component of a race-blind alternative admissions policy could be the elimination of "legacy" (children of alumni) preferences favoring non-minorities.[154] In addition, he suggests that socioeconomic admissions plan modeling might be improved through the use of applicant family wealth data.[155] Furthermore, he contends that

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[151] Kahlenberg Report, fn. 291.
[152] "Frequently Asked Questions," *USPS*, available at faq.usps.com; Hoxby Report, ¶ 264.
[153] As of a 2011 College Board revision, there were 33 "educational neighborhood" clusters. *See* "Segment Analysis Service," *College Board Search*, pp. 2–3, available at http://media.collegeboard.com/mSSS/media/pdf/segment-analysis-service-overview.pdf
[154] Kahlenberg Report, pp. 54–57.
[155] Kahlenberg Report, pp. 22–25.

the reduction in URM students that would follow on from a switch to a race-blind alternative admissions process might be offset by improved recruiting.[156]

1. Eliminating Alumni Preferences Is Not a Standalone Workable Race-Blind Alternative

171. I now consider what the size of the alumni preference applicants at UNC receive is, and what the likely effect of eliminating those preferences would be. For this exercise, I take Prof. Arcidiacono's model as given, even though I do not accept that it is an accurate or reliable reflection of UNC's admissions process. However, even under Prof. Arcidiacono's model, the impact of alumni preferences is too small for the elimination of such preferences to serve as a workable race-blind alternative on its own. Despite Mr. Kahlenberg's contention that size of the alumni preference is large (and, particularly so for out-of-state applicants)[157] the number of such students whose admissions decisions are impacted, even under Prof. Arcidiacono's model, which I do not accept, is comparatively low.

172. Even if one accepts Arcidiacono Model 4, which I do not, then the total number of students potentially affected by alumni preferences is too small to make a substantial difference in the ability of UNC to implement a workable race-blind alternative admissions plan: under Prof. Arcidiacono's Model 4, only 228 applicants in the average admissions cycle that Prof. Arcidiacono analyzes have their admissions decision affected by alumni preferences out of an average applicant pool of 27,285.

2. Mr. Kahlenberg's Claim that His Socioeconomic Plan Would Do Even Better if He Had Better Data (Such as Data on Wealth) Is Unfounded and Misleading

173. Mr. Kahlenberg claims that UNC could implement a socioeconomic admissions plan that includes measures of families' wealth and that such a plan would be especially effective at maintaining the university's racial diversity.[158] This claim is unfounded for two related reasons.

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[156] Kahlenberg Report, pp. 57–60.
[157] Kahlenberg Report, p. 55.
[158] Kahlenberg Report, p. 31, fn. 264, pp.74–75.

i. Wealth data that would allow universities to implement admissions plans based on wealth do not exist.

ii. In part because wealth data do not exist but for other reasons as well, the evidence upon which Mr. Kahlenberg's claim is based is extremely slight and problematic. Recent evidence indicates that wealth data would *not* improve the information available to an admissions office that already had students' achievement and the sort of socioeconomic data already incorporated in Mr. Kahlenberg's proposal (or the wider array of socioeconomic factors that I use in the plans I examine in my opening report).

174. Mr. Kahlenberg suggests that UNC could use data on students' wealth in a socioeconomic admissions plan.[159] He does not indicate how UNC could obtain such data. Indeed, his remarks suggest that he may be unaware that accurate wealth data are not only *not* possessed by the university but would be extremely difficult if not impossible to obtain.[160]

175. In fact, wealth data are not available for U.S. families, in part because answering wealth questions is inherently difficult. For instance, in order to compute wealth, families must be asked about the value of their (i) assets at financial institutions, (ii) other interest earning assets, (iii) stocks and mutual fund shares, (iv) equity in their businesses or profession, (v) equity in their own homes, (vi) equity in their motor vehicles, (vii) rental property equity, (viii) other real estate equity, (ix) retirement accounts, (x) education savings accounts, (xi) annuities and trusts, (xii) life insurance (its cash value), and (xii) other assets.[161] These are challenging questions to answer and, therefore, not asked in most surveys such as the Census or the American Community Survey.[162] When questions like this *are* asked, as they are in the Survey of Income and Program Participation, a substantial share of people (20 to 60 percent) prefer not to respond

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[159] "We did not have access to the family net worth/wealth of either in-state or out-of-state applicants, a factor that is more highly correlated with race than is parental education and income. As a result, the simulations likely form a lower bound estimate of the racial dividends of these strategies. Better data could produce higher levels of racial diversity." At p. 73 he claims "any modest decline in black representation could be addressed if UNC were to employ a wealth variable…" Kahlenberg Report, fn. 264.

[160] Mr. Kahlenberg suggests that UNC has wealth data (which it does not have) that it could have provided to him: "I did not have some of the data I would have liked to review from UNC, including precise data about student…wealth." Kahlenberg Report, pp. 3–4.

[161] *See*, "Survey of Income and Program Participation, Core Questionnaire, Assets," *US Census Bureau*, available at https://www.census.gov/programs-surveys/sipp/tech-documentation/questionnaires.html

[162] *See*, "Questions on the Form and Why We Ask," *US Census Bureau*, available at https://www.census.gov/acs/www/about/why-we-ask-each-question/

and others give answers that are approximate at best.[163] The Internal Revenue Service does not have data on families' wealth (except for the small share of very affluent families who pay the estate tax at a family member's death).[164] While families who file the Free Application for Federal Student Aid (FAFSA) are asked a few wealth-related questions (the value of their checking and savings accounts, for instance), they are not asked to report on the value of the home in which they live, their businesses or farms (unless they employ more than 100 full-time workers), their retirement accounts, their life insurance, or their motor vehicles.[165] Yet, the aforementioned categories (homes, businesses, etc.) are the main sources of wealth for all but the richest Americans. And, of course, very rich families do not file for federal financial aid.

176. In short, UNC not only does not have wealth data at present, it would be very difficult if not impossible for UNC to obtain it. Thus, Mr. Kahlenberg's suggestions regarding wealth-based admissions plans would appear to be not well-considered.

177. The fact that wealth data are scarce and problematic is one reason why there is almost no reliable evidence that wealth differences explain differences in college-going between URM and non-URM students. The other reason is that it is extremely hard for researchers to show that there is an effect of wealth itself, as opposed to the effects of family characteristics that are correlated with wealth: income, achievement, and so on. For instance, recent research suggests that while wealthier students are more likely to attend college, the correlation between wealth and college-going is eliminated once other factors (such as achievement) are taken into account.[166]

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[163] *See*, Czajka, J., J. Jacobson, and S. Cody, "Survey Estimates of Wealth: A Comparative Analysis and Review of the Survey of Income and Program Participation," *Social Security Bulletin* 65, no. 1. (2003/2004): 63–69; Eggleston, J., and M. Klee, "Reassessing wealth data quality in the Survey of Income and Program Participation," *SEHSD* Working Paper, (2016) 1–48 at p. 12.

[164] Johnson, B. and K. Moore, "Consider the Source: Differences in Estimates of Income and Wealth From Survey and Tax Data," *Special Studies in Federal Tax Statistics* (2005): 77–99 at pp. 3, 6, 19. Note that the Survey of Consumer Finances is anonymized: "The confidentiality of the information provided in the study is of the highest importance to NORC and the Federal Reserve," *Federal Reserve*, available at https://www.federalreserve.gov/econres/aboutscf.htm.

[165] "Business value does not include the value of a small business if your family owns and controls more than 50% of the business and the business has 100 or fewer full-time or full-time equivalent employees. For small business value, your family includes (1) persons directly related to you such as a parent, sister, or cousin or (2) persons who are or were related to you by marriage such as a spouse, stepparent, or sister-in-law," (S*ee*, "What is the net worth of your current business and / or investment farms?" *FASFA*, available at https://fafsa.ed.gov/fotw1819/help/fotw35c.htm); *See also*, "Privacy and Security Information," *FASFA*, available at https://fafsa.ed.gov/privacynotice.htm.

[166] *See*, Su Jin Jez, "The Influence of Wealth and Race in Four-Year College Attendance," *University of California at Berkeley, Center for Studies in Higher Education*, (2008).

178. Summing up, Mr. Kahlenberg's assertions regarding the use of wealth in an admissions plan would appear to be not just impractical but also founded on evidence that is, at best, weak.

3. Enhanced Recruiting Is Not Able to Fully Substitute for Losses Due to a Race-Blind Alternative

179. Mr. Kahlenberg makes a number of claims that suggest that UNC does a poor job in recruiting economically disadvantaged applicants, and suggests that through improved recruitment efforts, UNC would be able to offset the loss to diversity resulting from the switch to a race-blind admissions process.[167] In addition, Mr. Kahlenberg argues that UNC does not do well at matriculating disadvantaged students (though previously he has not considered the impact of his simulations on the matriculating class at all).[168]

180. Regardless, it is not clear how Mr. Kahlenberg reaches these conclusions. I have already demonstrated in my opening report (citing my own research on this question) that the vast majority (86 percent) of low-income, high-achieving students who do not apply to selective universities like UNC (what I call the missing "one-offs") are non-URMs.[169] Thus, contrary to Mr. Kahlenberg's claims, an increase in UNC's recruiting and information campaigns directed toward low-income students who are "one-offs" could not reasonably be expected to substitute for race-conscious admissions.[170]

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[167] Kahlenberg Report, p. 57: "More generally, UNC officials argued that recruitment was the key to putting UNC on 'solid footing for our diversity efforts' in the event the use of race were banned in admissions." Kahlenberg Report p. 58: "[T]he bottom line results suggest UNC does a poor job of recruiting economically disadvantaged applicants, many of whom are underrepresented minorities. For example, UNC does an especially poor job of recruiting into its applicant pool students whose parents do not have a college degree...".

[168] "Once students are accepted, UNC does a poor job of targeting disadvantaged students to come to campus. In 2013, for example, about one in five students (1817 of 8243) were invited to the special Excel program to encourage acceptance. Of those students deemed highly desirable by UNC, just 17.2% were first generation college students and just 19.5% were underrepresented minorities." Kahlenberg Report at p. 59

[169] Hoxby Report, ¶ 285.

[170] Hoxby Report, ¶ 286.

E. Mr. Kahlenberg Does Not Attempt to Evaluate Alternative Admissions Plans Solely on the Basis of Whether They Would Allow UNC to Maintain Racial Diversity. Instead, His Evaluation of Each Plan is Based Partly on Whether It Increases UNC's Socioeconomic Diversity.

181. Mr. Kahlenberg's report and opinions are colored by his clear preference for and desire to increase socioeconomic diversity. I understand the question at issue to be whether there is a workable alternative that would allow UNC to maintain *racial* diversity while also maintaining its academic standards. However, each time he evaluates a plan, Mr. Kahlenberg appears to value its attainment of socioeconomic diversity as much or more as its attainment of racial diversity: Mr. Kahlenberg says in his report that "the critical measure is the net impact on socioeconomic and racial diversity taken together."[171]

182. Moreover, recall the logic that my opening report established. It does not argue that socioeconomic proxies could not be used in admissions to increase *socioeconomic* diversity. Presumably, they could be so used. This point is noted multiple times in my opening report.[172] Rather, the logic of my opening report is that there is a trade-off to be faced by a university that substitutes socioeconomic proxies for race in an attempt to make its admissions process race-blind. By substituting race with socioeconomic proxies, the university always suffers costs along other dimensions that it cares about in admissions. The university cannot get back to the racial diversity it had previously, without suffering these costs, because the correlation between socioeconomic variables and race is far from perfect.[173]

VI. Conclusion

183. In my opening report, I conducted analyses of both UNC admissions data and data on all North Carolina public high school students and found, among other things, that (1) race is not a dominant factor in UNC admissions and (2) there is no workable race-blind alternative that would allow UNC to maintain its racial diversity while also maintaining its current academic standards. For the reasons detailed in this report, none of the analysis or opinions presented in

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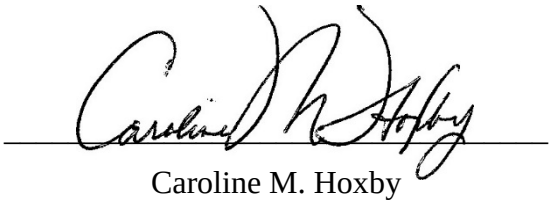
[171] Kahlenberg Report, p. 73.
[172] *See*, e.g., Hoxby Report, ¶ 134.
[173] *See*, Hoxby Report, Sections IV.B, V.A.

the Arcidiacono Report or Kahlenberg Report changes any of the opinions I presented in my opening report.

184. I reserve the right to amend or supplement my report and opinions in light of any additional information produced in the discovery process.

Dated: April 6, 2018



Caroline M. Hoxby

Exhibits

Share of Admissions Decision Due to Race/Ethnicity in Arcidiacono Models 2–7 [1]

2011-12 to 2016-17 Admissions Cycles [2]

Model	(A) Pseudo R^2 [3]	(B) Share of R^2 Due to Variables Other Than Race/Ethnicity	(C) Share of R^2 Due to Race/Ethnicity	(D)= (C) x (A) Share of Admissions Decision Due to Race/Ethnicity
Model 2				
In-State	0.565	96.4%	3.6%	2.0%
Out-of-State	0.416	86.6%	13.4%	5.6%
Model 3				
In-State	0.715	96.4%	3.6%	2.6%
Out-of-State	0.584	88.8%	11.2%	6.5%
Model 4				
In-State	0.716	96.2%	3.8%	2.7%
Out-of-State	0.586	88.5%	11.5%	6.7%
Model 5				
In-State	0.712	96.3%	3.7%	2.6%
Out-of-State	0.582	88.6%	11.4%	6.6%
Model 6				
In-State	0.750	96.7%	3.3%	2.5%
Out-of-State	0.644	90.4%	9.6%	6.2%
Model 7 [4]				
In-State	0.768	96.6%	3.4%	2.6%

Source: Connect Carolina; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note:

[1] A Shapley decomposition is performed for each of the Arcidiacono Models, which are run separately on in-state and out-of-state applicants. Note that this Exhibit is based on Arcidiacono Models 2–7, which do not accurately reflect UNC's admissions process or decisions.

[2] The 2011-12 to 2016-17 admissions cycles refer to the classes of 2016 through 2021 per Arcidiacono's terminology.

[3] See the Arcidiacono Report Tables A.4.1 and A.4.2.

[4] Arcidiacono does not estimate Model 7 for out-of-state applicants. Model 7 includes Census "Tract" fixed effects. Additionally, Arcidiacono's Model 7 cannot be run on in-state applicants from the 2016-17 cycle due to a lack of Census Tract information in that cycle.

EXHIBIT 2 FIGURE 1a

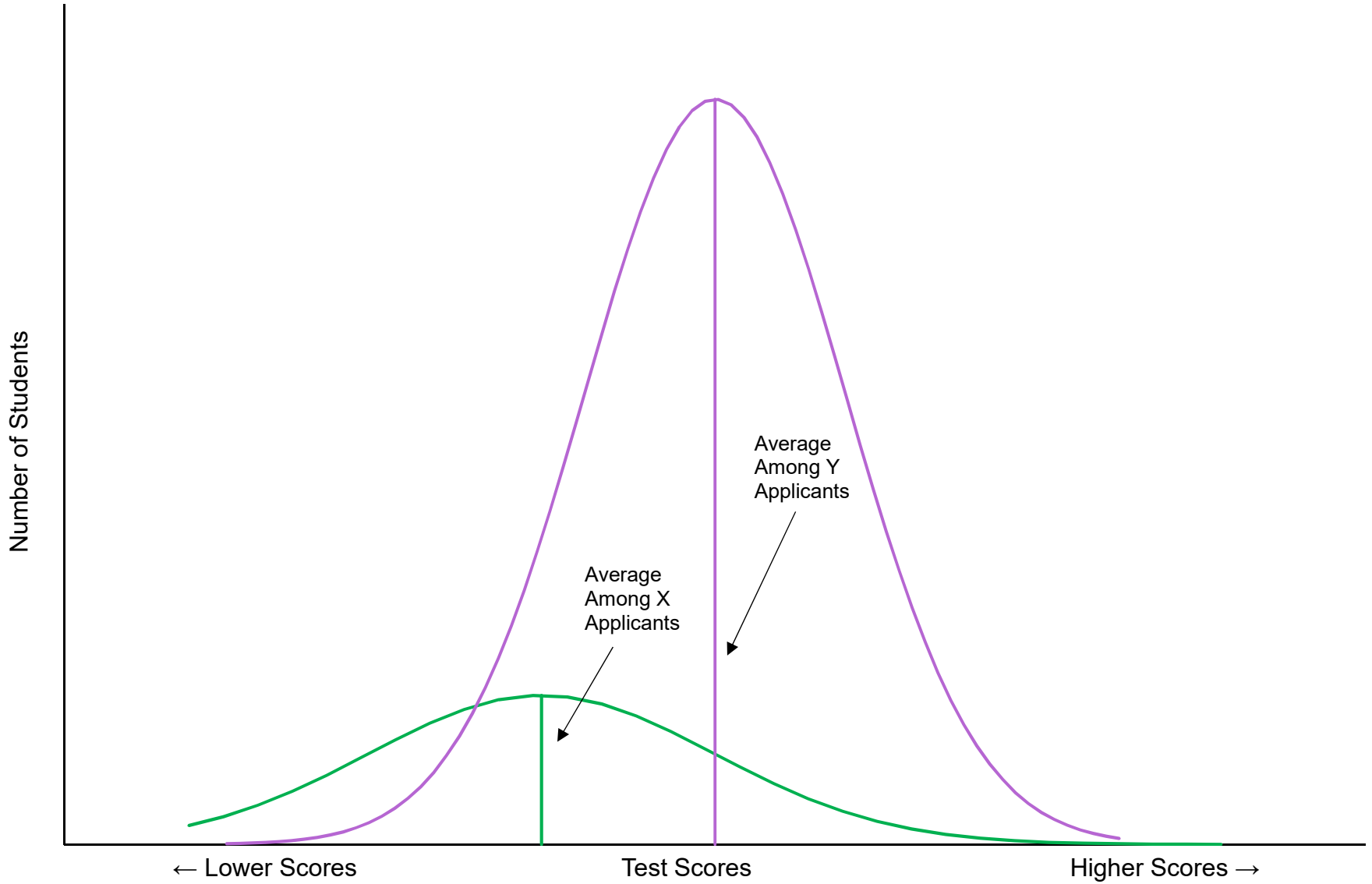
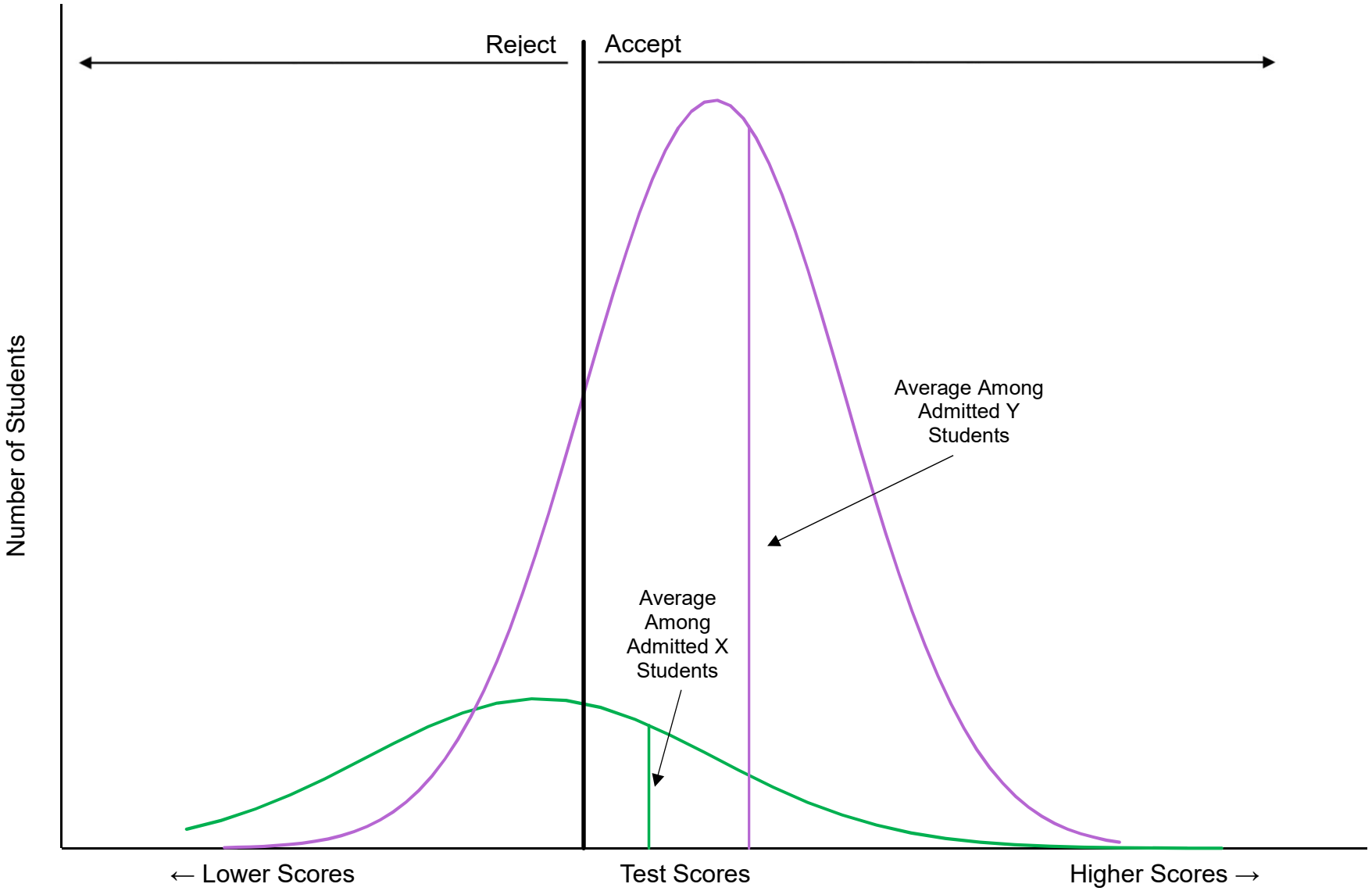
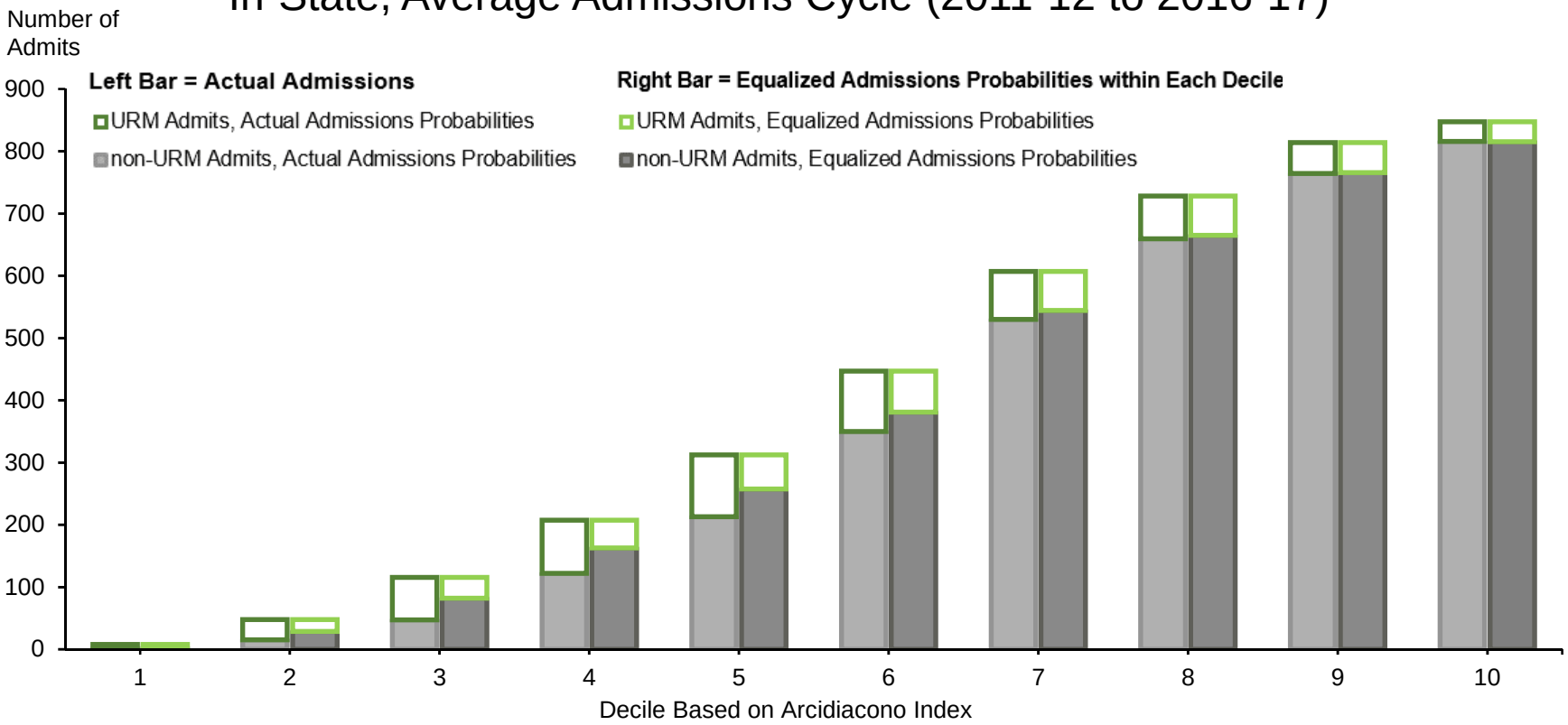


EXHIBIT 2 FIGURE 1b



UNC Admits by Decile Based on Arcidiacono Index

In-State, Average Admissions Cycle (2011-12 to 2016-17)

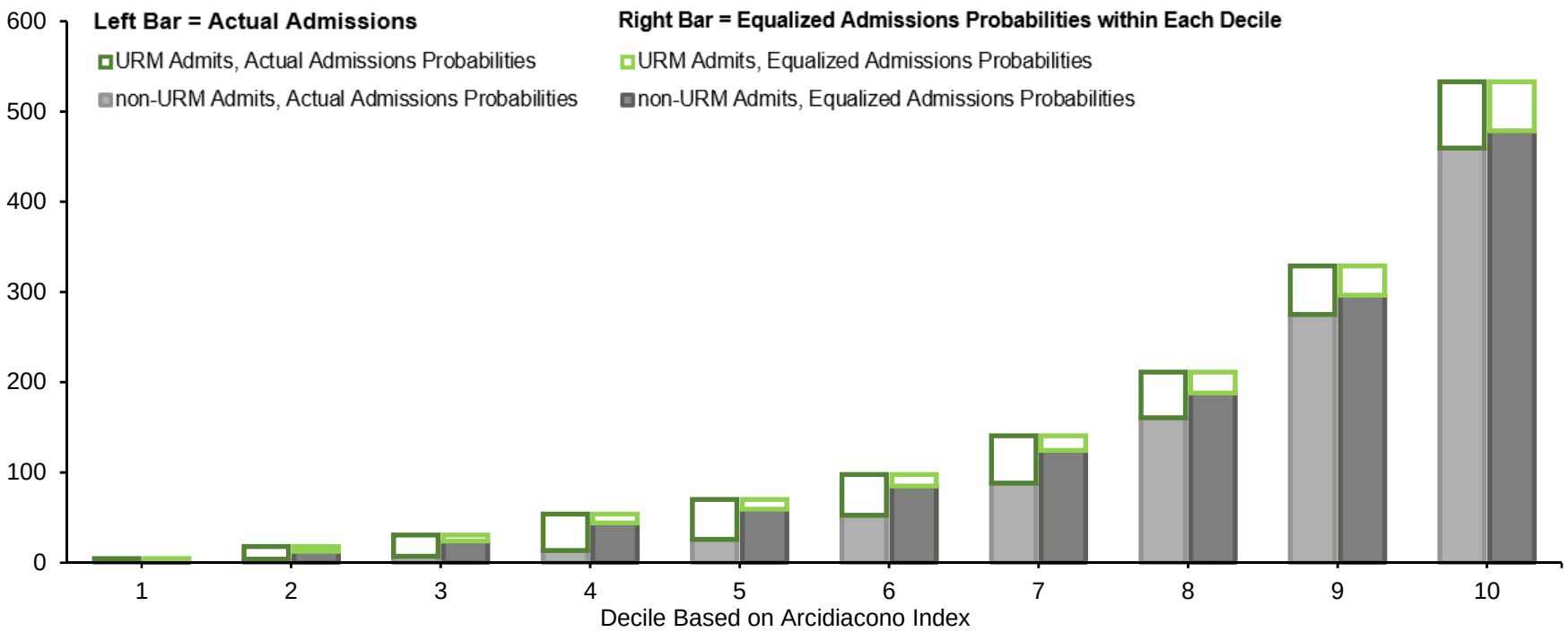


Source: Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note: The in-state applicants represented in Arcidiacono Report Table 3.1 represent six admissions cycles, 2011-12 to 2016-17 (this refers to the classes of 2016 to 2021 per Arcidiacono's terminology). For each Arcidiacono Index decile, this number is divided by six to represent the average admissions cycle. The in-state admissions probabilities by Arcidiacono Index decile and race/ethnicity in Arcidiacono Report Table 3.3 are used to calculate the actual in-state admits for the average admissions cycle. To equalize admissions probabilities within each decile, the number of URM and non-URM admits for the average admissions cycle are adjusted such that the average admissions probability for each category is equal to the total admissions probability by Arcidiacono Index decile in Arcidiacono Report Table 3.3. To be consistent with the Kahlenberg/Arcidiacono Reports, under-represented minorities ("URM") include African American and Hispanic applicants (and not Native Americans) and non-URM include Asian and white applicants. This Figure excludes Other/NA individuals which includes individuals who identified as Native American, Pacific Islander, or had a missing race/ethnicity. This Figure also excludes students who were excluded by Arcidiacono: students who are foreign, are considered to be in “special recruiting categories” according to Arcidiacono, are missing ratings variables, have incomplete applications, or were previously admitted. Applicants missing GPAs or test scores are also excluded, as these fields are needed to calculate the Arcidiacono Index. In total, the Figure includes 24,808 in-state admits, averaging to 4,135 for each of the six admissions cycles. Note that this Figure is based on the Arcidiacono Index, which does not accurately reflect UNC’s admissions process or decisions. This Figure does not say anything about what would happen under an actual race-blind admissions plan.

UNC Admits by Decile Based on Arcidiacono Index

Out-of-State, Average Admissions Cycle (2011-12 to 2016-17)

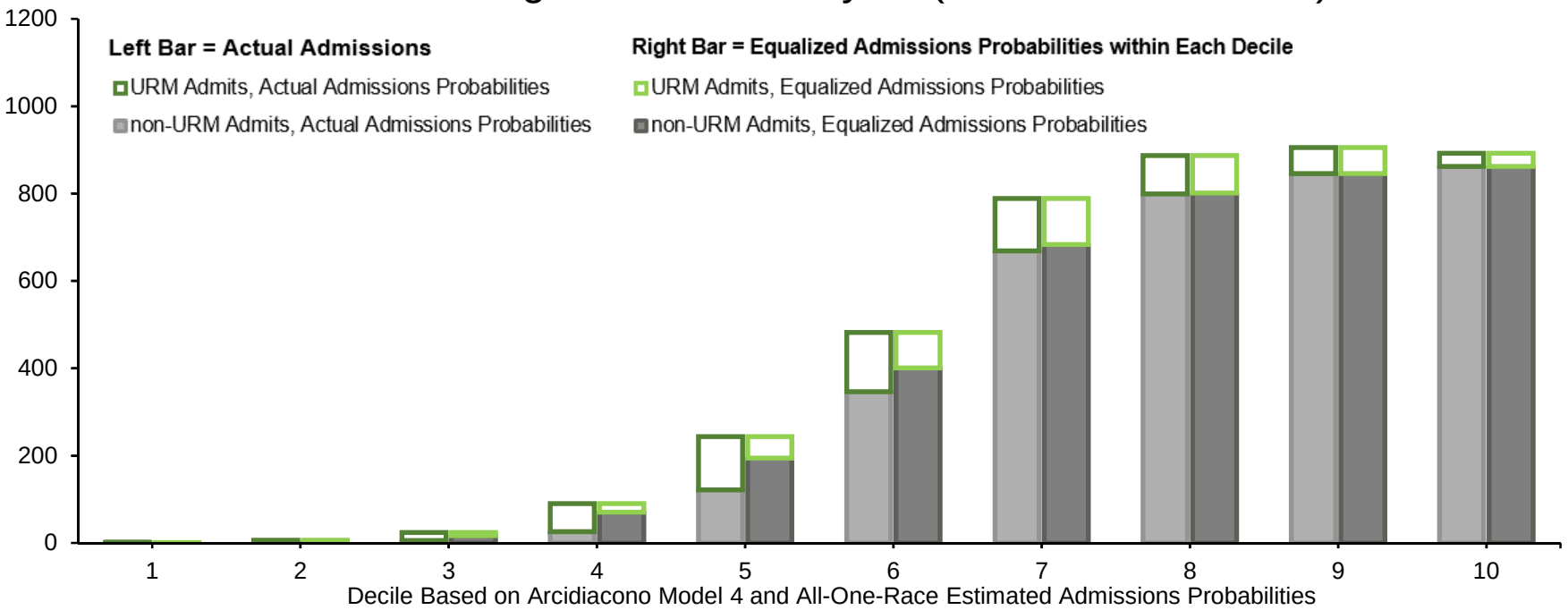


Source: Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note: The out-of-state applicants represented in Arcidiacono Report Table 3.2 represent six admissions cycles, 2011-12 to 2016-17 (this refers to the classes of 2016 to 2021 per Arcidiacono's terminology). For each Arcidiacono Index decile, this number is divided by six to represent the average admissions cycle. The out-of-state admissions probabilities by Arcidiacono Index decile and race/ethnicity in Arcidiacono Report Table 3.4 are used to calculate the actual out-of-state admits for the average admissions cycle. To equalize admissions probabilities within each decile, the number of URM and non-URM admits for the average admissions cycle are adjusted such that the average admissions probability for each category is equal to the total admissions probability by Arcidiacono Index decile in Arcidiacono Report Table 3.4. To be consistent with the Kahlenberg/Arcidiacono Reports, under-represented minorities ("URM") include African American and Hispanic applicants (and not Native Americans) and non-URM include Asian and white applicants. This Figure excludes Other/NA individuals which includes individuals who identified as Native American, Pacific Islander, or had a missing race/ethnicity. This Figure also excludes students who were excluded by Arcidiacono: students who are foreign, are considered to be in "special recruiting categories" according to Arcidiacono, are missing ratings variables, have incomplete applications, or were previously admitted. Applicants missing GPAs or test scores are also excluded, as these fields are needed to calculate the Arcidiacono Index. In total, the Figure includes 8,933 out-of-state admits, averaging to 1,489 for each of the six admissions cycles. Note that this Figure is based on the Arcidiacono Index, which does not accurately reflect UNC's admissions process or decisions. This Figure does not say anything about what would happen under an actual race-blind admissions plan.

UNC Admits by Decile Based on Arcidiacono Model 4 and All-One-Race Estimated Admissions Probabilities

In-State, Average Admissions Cycle (2011-12 to 2016-17)

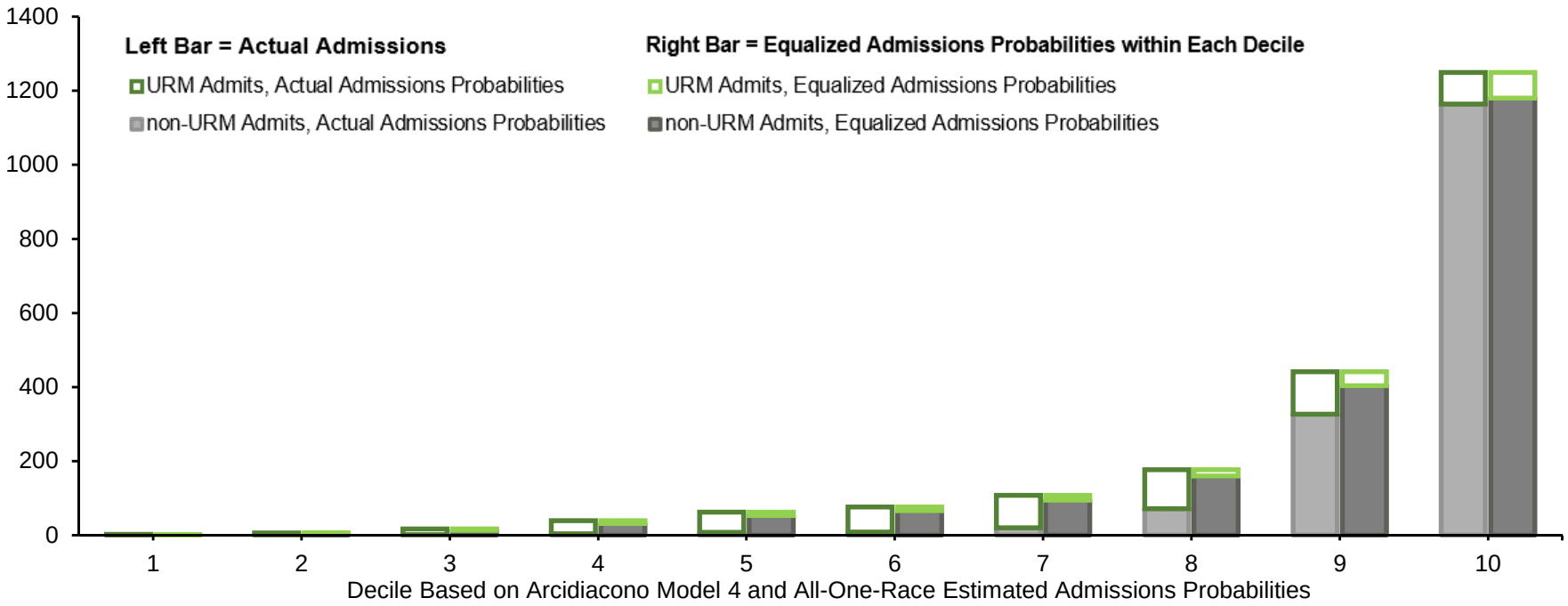


Source: Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note: The in-state applicants represented in the Arcidiacono Report Section 4 represent six admissions cycles, 2011-12 to 2016-17 (this refers to the classes of 2016 to 2021 per Arcidiacono's terminology). Arcidiacono Model 4 is used to predict admissions probabilities for in-state applicants in these admissions cycles. Consistent with his methodology, the race/ethnicity term, but not the race/ethnicity term interacted with missing percentiles, missing GPAs, and rank type, is changed to African American, for all students, prior to calculating admissions probabilities. Across all six admissions cycles, in-state applicants are binned into deciles based on these probabilities. Actual admissions decisions for the students in these deciles are used to calculate the actual in-state admits, within each decile, across all six admissions cycles, and is divided by six to represent the average admissions cycle. To equalize admissions probabilities within each decile, the number of URM and non-URM admits for the average admissions cycle are adjusted such that the average admissions probability for each category is equal to the total admissions probability in each decile. To be consistent with the Kahlenberg/Arcidiacono Reports, under-represented minorities ("URM") include African American and Hispanic applicants (and not Native Americans) and non-URM include Asian and white applicants. This Figure excludes Other/NA individuals which includes individuals who identified Native American, Pacific Islander, or had a missing race/ethnicity. This Figure also excludes students who were excluded by Arcidiacono: students who are foreign, are considered to be in “special recruiting categories” according to Arcidiacono, are missing ratings variables, have incomplete applications, or were previously admitted. In total, the Figure includes 25,932 in-state admits, averaging to 4,322 for each of the six admissions cycles. Note that this Figure is based on Arcidiacono Model 4, which does not accurately reflect UNC’s admissions process or decisions. This Figure does not say anything about what would happen under an actual race-blind admissions plan.

UNC Admits by Decile Based on Arcidiacono Model 4 and All-One-Race Estimated Admissions Probabilities

Out-of-State, Average Admissions Cycle (2011-12 to 2016-17)

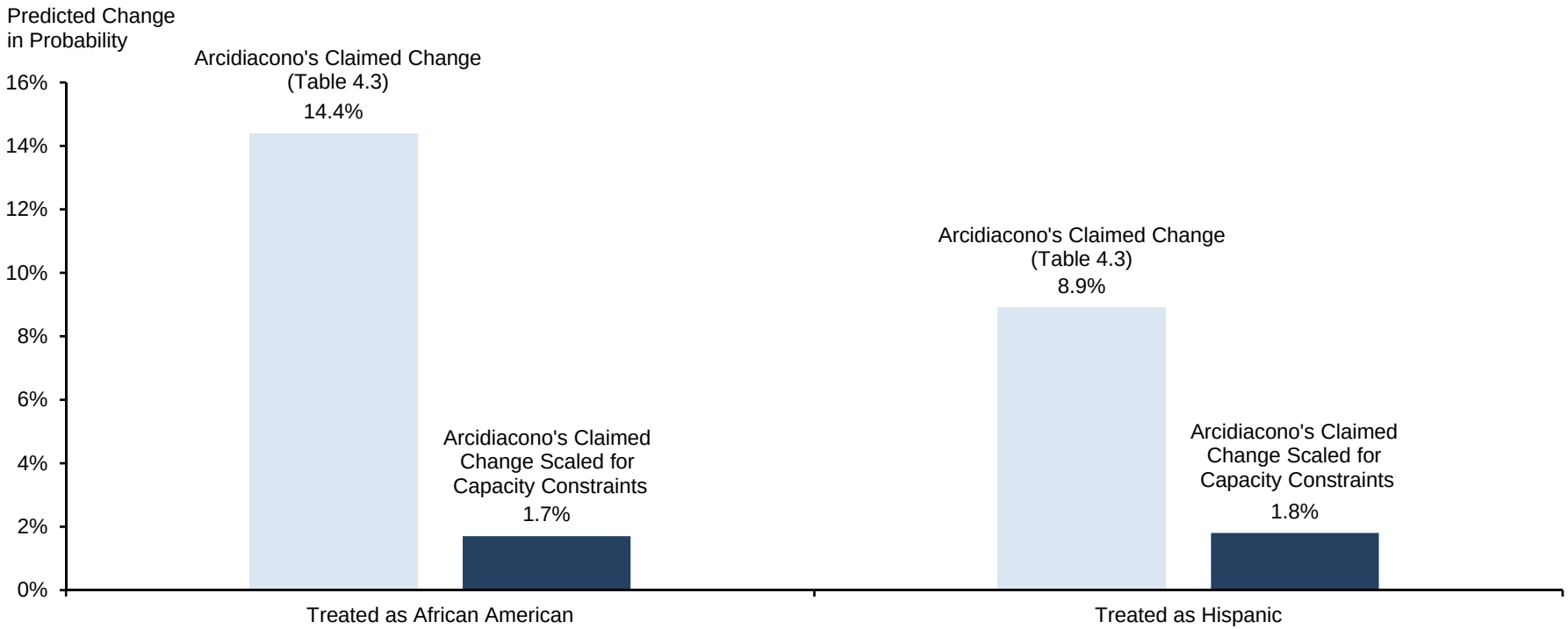


Source: Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note: The out-of-state applicants represented in the Arcidiacono Section 4 represent six admissions cycles, 2011-12 to 2016-17 (this refers to the classes of 2016 to 2021 per Arcidiacono's terminology). Arcidiacono Model 4 is used to predict admissions probabilities for out-of-state applicants in these admissions cycles. Consistent with his methodology, the race/ethnicity term, but not the race/ethnicity term interacted with missing percentiles, missing GPAs, and rank type, is changed to African American, for all students, prior to calculating admissions probabilities. Across all six admissions cycles, out-of-state applicants are binned into deciles based on these probabilities. Actual admissions decisions for the students in these deciles are used to calculate the actual out-of-state admits, within each decile, across all six admissions cycles, and is divided by six to represent the average admissions cycle. To equalize admissions probabilities within each decile, the number of URM and non-URM admits for the average admissions cycle are adjusted such that the average admissions probability for each category is equal to the total admissions probability in each decile. To be consistent with the Kahlenberg/Arcidiacono Reports, under-represented minorities ("URM") include African American and Hispanic applicants (and not Native Americans) and non-URM include Asian and white applicants. This Figure excludes Other/NA individuals which includes individuals who identified as Native American, Pacific Islander, or had a missing race/ethnicity. This Figure also excludes students who were excluded by Arcidiacono: students who are foreign, are considered to be in "special recruiting categories" according to Arcidiacono, are missing ratings variables, have incomplete applications, or were previously admitted. In total, the Figure includes 13,078 out-of-state admits, averaging to 2,180 for each of the six admissions cycles. Note that this Figure is based on Arcidiacono Model 4, which does not accurately reflect UNC's admissions process or decisions. This Figure does not say anything about what would happen under an actual race-blind admissions plan.

Predicted Change in Probability of Admissions of Asian Students If Treated as African American or Hispanic

In-State, 2011-12 to 2016-17 Admissions Cycles

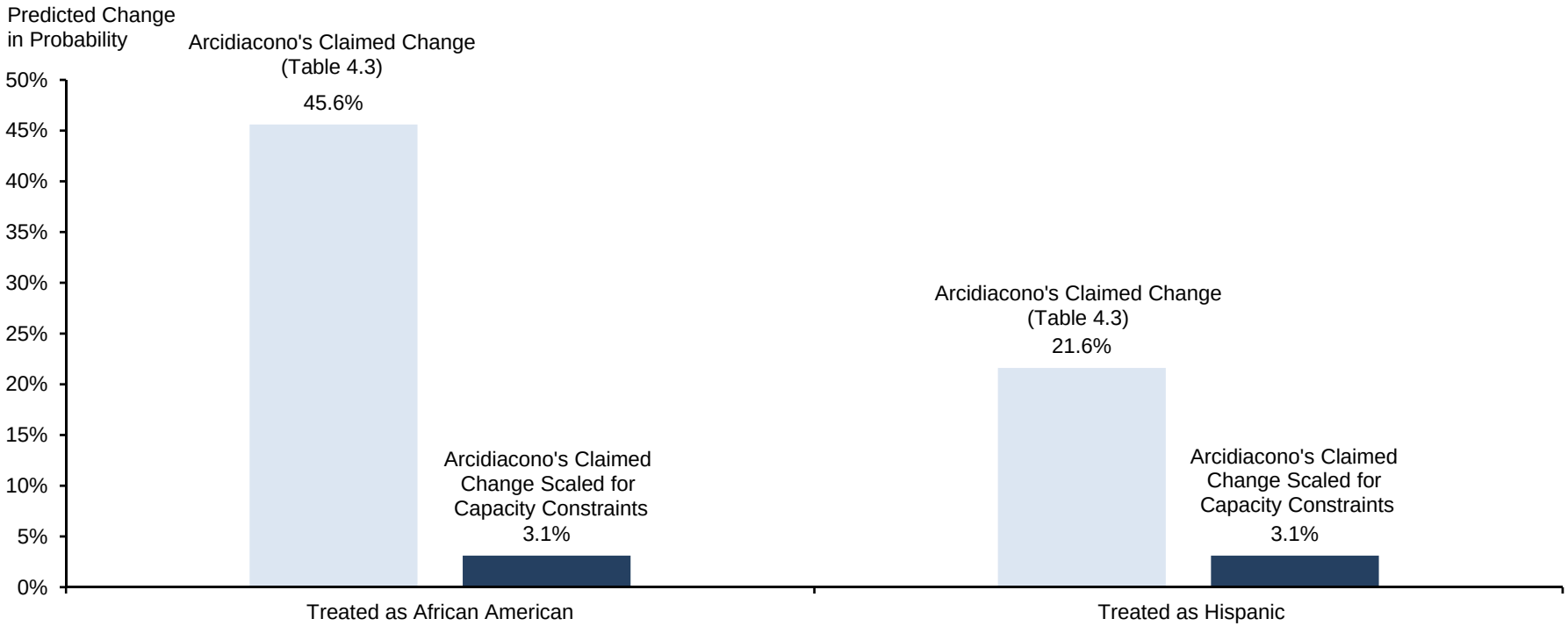


Source: Connect Carolina; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note: The 2011-12 to 2016-17 admissions cycles refer to the classes of 2016 through 2021 per Arcidiacono's terminology. Arcidiacono Model 4 is used to predict admissions probabilities for in-state Asian students, in these admissions cycles. Consistent with his methodology, the race/ethnicity term, but not the race/ethnicity term interacted with missing percentiles, missing GPAs, and rank type, is changed to African American or Hispanic, and the admissions probabilities are recalculated based on Arcidiacono Model 4 regression coefficients. The mean change in admissions probability for in-state Asian students if they are treated as African American or Hispanic that Arcidiacono reports in Table 4.3 Model 4 is labeled "Arcidiacono's Claimed Change (Table 4.3)." Adjusted admissions probabilities are scaled, per Arcidiacono's methodology, to maintain the original number of admitted students in the sample. The mean change between the scaled counterfactual and original admissions probability is reported and labeled "Arcidiacono's Claimed Change Scaled for Capacity Constraints." Note that this Figure is based on Arcidiacono Model 4, which does not accurately reflect UNC's admissions process or decisions. This Figure does not say anything about what would happen under an actual race-blind admissions plan.

Predicted Change in Probability of Admissions of Asian Students If Treated as African American or Hispanic

Out-of-State, 2011-12 to 2016-17 Admissions Cycles



Source: Connect Carolina; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note: The 2011-12 to 2016-17 admissions cycles refer to the classes of 2016 through 2021 per Arcidiacono's terminology. Arcidiacono Model 4 is used to predict admissions probabilities for out-of-state Asian students, in these admissions cycles. Consistent with his methodology, the race/ethnicity term, but not the race/ethnicity term interacted with missing percentiles, missing GPAs, and rank type, is changed to African American or Hispanic, and the admissions probabilities are recalculated based on Arcidiacono Model 4 regression coefficients. The mean change in admissions probability for out-of-state Asian students if they are treated as African American or Hispanic that Arcidiacono reports in Table 4.3 Model 4 is labeled "Arcidiacono's Claimed Change (Table 4.3)." Adjusted admissions probabilities are scaled, per Arcidiacono's methodology, to maintain the original number of admitted students in the sample. The mean change between the scaled counterfactual and original admissions probability is reported and labeled "Arcidiacono's Claimed Change Scaled for Capacity Constraints." Note that this Figure is based on Arcidiacono Model 4, which does not accurately reflect UNC's admissions process or decisions. This Figure does not say anything about what would happen under an actual race-blind admissions plan.

Change in Non-URM Admits with Equalized Admissions Probabilities within Each Arcidiacono Index Decile

Average Admissions Cycle (2011-12 to 2016-17) [1]

Decile Based on Arcidiacono Index	Change in non-URM In-State Admits [2]			Change in non-URM Out-of-State Admits [2]		
	Change in non-URM Admits [3]	Change as a Share of In-State Admits [4]	Change as a Share of All Admits [5]	Change in non-URM Admits [3]	Change as a Share of Out-of-State Admits [4]	Change as a Share of All Admits [5]
1	1	0.02%	0.02%	0	-0.01%	0.00%
2	13	0.32%	0.24%	9	0.58%	0.15%
3	35	0.84%	0.62%	17	1.13%	0.30%
4	41	0.99%	0.73%	30	2.04%	0.54%
5	44	1.07%	0.79%	34	2.25%	0.60%
6	31	0.75%	0.55%	33	2.20%	0.58%
7	14	0.34%	0.25%	36	2.44%	0.64%
8	5	0.13%	0.10%	27	1.82%	0.48%
9	2	0.04%	0.03%	21	1.43%	0.38%
10	0	-0.01%	0.00%	19	1.28%	0.34%

Source: Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note:

[1] Arcidiacono Report Tables 3.1 and 3.2 represent applicant numbers from six admissions cycles, 2011-12 to 2016-17 (this refers to the classes of 2016 to 2021 per Arcidiacono's terminology). For each Arcidiacono Index decile, the number of applicants is divided by six to represent the average admissions cycle. The in-state and out-of-state admissions probabilities by Arcidiacono Index decile and race/ethnicity in Arcidiacono Report Tables 3.3 and 3.4 are used to calculate the actual in-state and out-of-state admits for the average admissions cycle. To equalize admissions probabilities within each decile, the number of URM and non-URM admits for the average admissions cycle are adjusted such that the average admissions probability for each category is equal to the total admissions probability by Arcidiacono Index decile in Arcidiacono Report Tables 3.3 and 3.4. Note that this Exhibit is based on the Arcidiacono Index, which does not accurately reflect UNC's admissions process or decisions. This Exhibit does not say anything about what would happen under an actual race-blind admissions plan.

[2] To be consistent with the Kahlenberg/Arcidiacono Reports, under-represented minorities ("URM") include African American and Hispanic applicants (and not Native Americans) and non-URM include Asian and white applicants. This Exhibit excludes Other/NA individuals which includes individuals who identified as Native American, Pacific Islander, or had a missing race/ethnicity. This Exhibit also excludes students who were excluded by Arcidiacono: students who are foreign, are considered to be in "special recruiting categories" according to Arcidiacono, are missing ratings variables, have incomplete applications, or were previously admitted. Applicants missing GPAs or test scores are also excluded, as these fields are needed to calculate the Arcidiacono Index.

[3] The change in non-URM admits is calculated as the difference between the number of non-URM admits in the average admissions cycle and the number of non-URM admits in the average admissions cycle after equalizing URM and non-URM admission probabilities within each decile. This number is rounded to the nearest integer.

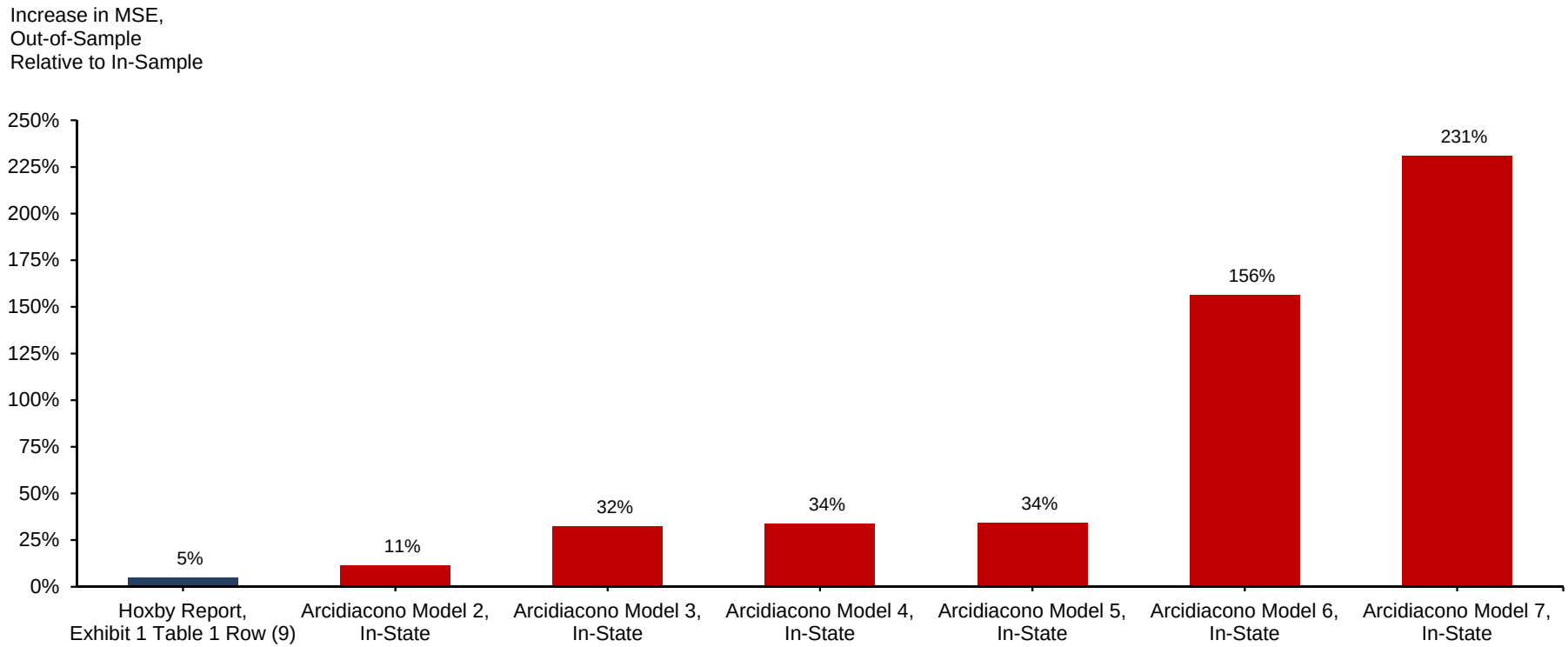
[4] The change in in-state or out-of-state non-URM admits per decile is divided by the total number of in-state or out-of-state URM and non-URM admits, in an average admissions cycle. Due to the rounding of the change in the number of admits, a change of zero in the rounded number of admits in this Exhibit can correspond to a non-zero change in the share admits in this Exhibit.

[5] The change in in-state or out-of-state non-URM admits per decile is divided by the total number of URM and non-URM admits, in an average admissions cycle. Due to the rounding of the change in the number of admits, a change of zero in the rounded number of admits in this Exhibit can correspond to a non-zero change in the share admits in this Exhibit.

EXHIBIT 3 FIGURE 1

Mean Squared Errors of Admissions Decision Predictions

2014-15 to 2016-17 Admissions Cycles, In-State

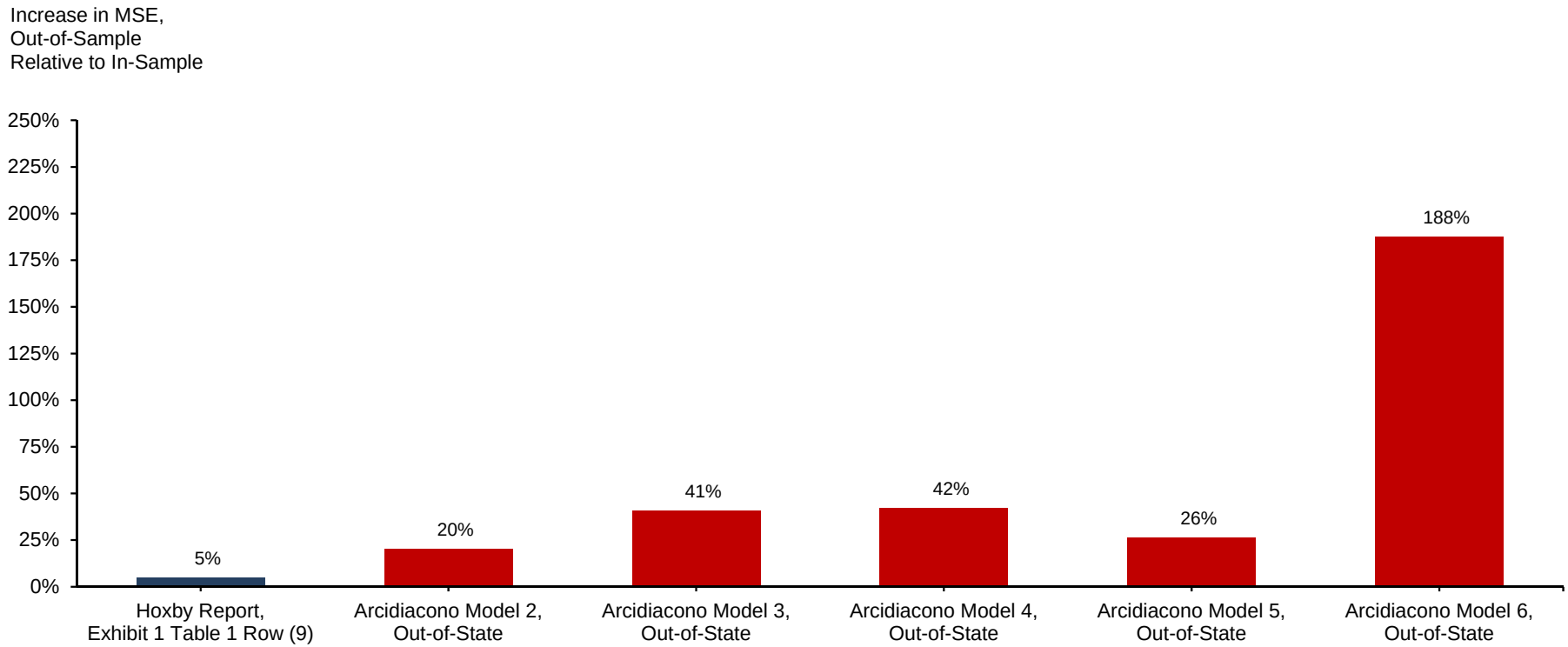


Source: College Board; Connect Carolina; Expert Report and Production of Caroline M. Hoxby, January 12, 2018; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018
Note: For Arcidiacono Models 2–7, described in his Figure 4.1 and for Hoxby Report Exhibit 1 Table 1 row (9), the regression is run separately on each of the 2014-15 to 2016-17 admissions cycles. The 2014-15 to 2016-17 admissions cycles refer to the classes of 2019 to 2021 per Arcidiacono's terminology. The admissions cycle used to run the regression is referred to as "in-sample," whereas the other admissions cycles from 2014-15 to 2016-17 are considered "out-of-sample." For each admissions cycle, the resulting coefficients are used to predict admissions for out-of-sample applicants that meet the same exclusion criteria specified in the original regression. Arcidiacono Models 2–7 are run on in-state applicants in Connect Carolina data. Hoxby Report Exhibit 1 Table 1 row (9) pools in-state and out-of-state applicants. For each regression and admissions cycle from 2014-15 to 2016-17, the actual admissions decision of each student is subtracted from their predicted admissions probability, and this result is squared. The mean squared error ("MSE") is computed for each admissions cycle, and the percentage increase of MSE from the in-sample admissions cycles to each out-of-sample admissions cycle is calculated. The average of the percentage increase in MSE is then taken across the admissions cycles. Due to a change in the recording methodology of parent/guardian education level after 2013-14, which is used in Hoxby Report Exhibit 1 Table 1 row (9), the calculation of MSE starts in 2014-15. No MSE is calculated for Arcidiacono Model 7 in the 2016-17 cycle due to a lack of Census Tract information in that cycle.

EXHIBIT 3 FIGURE 2

Mean Squared Errors of Admissions Decision Predictions

2014-15 to 2016-17 Admissions Cycles, Out-of-State



Source: College Board; Connect Carolina; Expert Report and Production of Caroline M. Hoxby, January 12, 2018; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018
Note: For Arcidiacono Models 2–6, described in his Figure 4.1 and for Hoxby Report Exhibit 1 Table 1 row (9), the regression is run separately on each of the 2014-15 to 2016-17 admissions cycles. The 2014-15 to 2016-17 admissions cycles refer to the classes of 2019 to 2021 per Arcidiacono's terminology. Arcidiacono does not employ Model 7 for out-of-state applicants. Model 7 includes Census Tract fixed effects, which are not relevant for out-of-state applicants. The admissions cycle used to run the regression is referred to as "in-sample," whereas the other admissions cycles from 2014-15 to 2016-17 are considered "out-of-sample." For each admissions cycle, the resulting coefficients are used to predict admissions for out-of-sample applicants that meet the same exclusion criteria specified in the original regression. Arcidiacono Models 2–6 are run on out-of-state applicants in Connect Carolina data. Hoxby Report Exhibit 1 Table 1 row (9) pools in-state and out-of-state applicants. For each regression and admissions cycle from 2014-15 to 2016-17, the actual admissions decision of each student is subtracted from their predicted admissions probability, and this result is squared. The mean squared error ("MSE") is computed for each admissions cycle, and the percentage increase of MSE from the in-sample admissions cycles to each out-of-sample admissions cycle is calculated. The average of the percentage increase in MSE is then taken across the admissions cycles. Due to a change in the recording methodology of parent/guardian education level after 2013-14, which is used in Hoxby Report Exhibit 1 Table 1 row (9), the calculation of MSE starts in 2014-15.

Shrinkage Statistics of Admissions Decision Predictions [1]

2011-12 to 2016-17 Admissions Cycles, In-State [2]

	Overfitting Shrinkage	
Specification	**Average Shrinkage Estimate**	**Standard Error**
Hoxby Report		
Exhibit 1 Table 1 Row (9) [3]	0.072	0.008
Arcidiacono Report [4]		
Model 2, In-State	0.112	0.010
Model 3, In-State	0.135	0.007
Model 4, In-State	0.166	0.010
Model 5, In-State	0.192	0.012
Model 6, In-State	1.225	0.025
Model 7, In-State	3.116	0.043

Source: Bilger and Manning (2015); College Board; Connect Carolina; Expert Report and Production of Caroline M. Hoxby, January 12, 2018; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018; Marcel Bilger's overfit.ado

Note:

[1] Shrinkage estimates are calculated using 10-fold cross-validation, repeated five times. Overfitting shrinkage is calculated as per Bilger and Manning (2015), via Marcel Bilger's overfit.ado Stata program.

[2] The 2011-12 to 2016-17 admissions cycles refer to the classes of 2016 through 2021 per Arcidiacono's terminology.

[3] The regression employed is from Hoxby Exhibit 1 Table 1 row (9), based on Connect Carolina data from the 2014-15 to 2016-17 admissions cycles. The model pools in-state and out-of-state applicants. Due to a change in the recording methodology of parent/guardian education level after 2013-14, only cycles after 2013-14 are used.

[4] Arcidiacono Models 2–6 are run on in-state applicants in Connect Carolina data from the 2011-12 to 2016-17 admissions cycles. Arcidiacono Model 7 cannot be run on the 2016-17 cycle due to a lack of Census Tract information in that cycle, and therefore Arcidiacono Model 7 is run on in-state applicants in Connect Carolina data from the 2011-12 to 2015-16 admissions cycles.

Shrinkage Statistics of Admissions Decision Predictions [1]

2011-12 to 2016-17 Admissions Cycles, Out-of-State [2]

Specification	Overfitting Shrinkage	
	Average Shrinkage Estimate	Standard Error
Hoxby Report		
Exhibit 1 Table 1 Row (9) [3]	0.072	0.008
Arcidiacono Report [4]		
Model 2, Out-of-State	0.205	0.016
Model 3, Out-of-State	0.213	0.013
Model 4, Out-of-State	0.263	0.015
Model 5, Out-of-State	0.340	0.014
Model 6, Out-of-State	7.607	0.039

Source: Bilger and Manning (2015); College Board; Connect Carolina; Expert Report and Production of Caroline M. Hoxby, January 12, 2018; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018; Marcel Bilger's overfit.ado

Note:

[1] Shrinkage estimates are calculated using 10-fold cross-validation, repeated five times. Overfitting shrinkage is calculated as per Bilger and Manning (2015), via Marcel Bilger's overfit.ado Stata program.

[2] The 2011-12 to 2016-17 admissions cycles refer to the classes of 2016 through 2021 per Arcidiacono's terminology.

[3] The regression employed is from Hoxby Exhibit 1 Table 1 row (9), based on Connect Carolina data from the 2014-15 to 2016-17 admissions cycles. The model pools in-state and out-of-state applicants. Due to a change in the recording methodology of parent/guardian education level after 2013-14, only cycles after 2013-14 are used.

[4] Arcidiacono Models 2–6, are run on out-of-state applicants in Connect Carolina data from the 2011-12 to 2016-17 admissions cycles. Arcidiacono does not employ Model 7 for out-of-state applicants. Model 7 includes Census Tract fixed effects, which are not relevant for out-of-state applicants.

EXHIBIT 5

Sensitivities of Arcidiacono Models 2 and 3: Impact of Excluding "Special Recruiting Category" Students and Including Ratings [1]

2011-12 to 2016-17 Admissions Cycles [2]

Model Relative to Arcidiacono Report Specifications	Pseudo R^2	Coefficient on African American Race/Ethnicity Indicator	Coefficient on Hispanic Race/Ethnicity Indicator
In-State			
Arcidiacono Model 3 [3]	0.715	2.85	1.81
Arcidiacono Model 3 without Excluding "Special Recruiting Category" Students [3][4]	0.688	2.41	1.53
Arcidiacono Model 2	0.565	1.84	1.27
Arcidiacono Model 2 without Excluding "Special Recruiting Category" Students [4]	0.556	1.72	1.17
Out-of-State			
Arcidiacono Model 3 [3]	0.584	5.85	3.01
Arcidiacono Model 3 without Excluding "Special Recruiting Category" Students [3][4]	0.523	4.32	2.30
Arcidiacono Model 2	0.416	4.68	2.43
Arcidiacono Model 2 without Excluding "Special Recruiting Category" Students [4]	0.352	3.75	1.95

Source: Connect Carolina; Connect Carolina Flat File Data Definitions; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note:

[1] Note that this Exhibit is based on Arcidiacono Models 2 and 3, which do not accurately reflect UNC's admissions process or decisions. This Exhibit does not say anything about what would happen under an actual race-blind admissions plan.

[2] The 2011-12 to 2016-17 admissions cycles refer to the classes of 2016 through 2021 per Arcidiacono's terminology.

[3] All of Arcidiacono Models 3 and higher include the five ratings variables: program, performance, extracurricular activities, essay, and personal qualities.

[4] Variables that indicate a student is a "Special Recruiting Category" student have the following definitions, according to the Connect Carolina data dictionary: doesn't meet ACG, advanced courses, Alamance Community College, attended Camp Carolina, member of Carolina Student Transfer Excellence Program, distinction, Dean of Students access (related to disciplinary issues), Dean of Students cleared, drama possible, drama final, Durham Tech Community College, external program, previously used to mark Honors Carolina nominees, Honors Carolina invitee, Innovation Scholars access rights, men's JV basketball, student received likely letter, Morehead-Cain access rights, music final, Pogue Scholarship alternate, Pogue access rights, Pogue finalist, Pogue nominee, Pogue semi-finalist, Pogue winner, priority oos, Robertson alternate, Robertson finalist, Robertson semifinalist, Robertson winner, sub-d final (learning disability self-disclosed), scholarship invitee day 1, scholarship invitee day 2, science, Trademark Scholarship, Project Uplift attendee, special talent athlete.

EXHIBIT 6

KA Simulation 3 (Socioeconomic Status-Based Plan) Using Arcidiacono Model 2 and NCERDC Data [1]

2014-15 Admissions Cycle [2]

	Status Quo (Actual UNC Resident Public School Admits) [3]			Kahlenberg/Arcidiacono Simulation 3 Applied to NCERDC [4]			Kahlenberg/Arcidiacono Simulation 3 Applied to NCERDC and Scaled [5]		
Race/Ethnicity [6]	**Total Admits**	**Avg. SAT Score [7]**	**Avg. GPA [8]**	**Total Admits**	**Avg. SAT Score [7]**	**Avg. GPA [8]**	**Total Admits**	**Avg. SAT Score [7]**	**Avg. GPA [8]**
African American	293	1196	4.57	8,322	878	4.09	665	1028	4.56
Asian	401	1349	4.78	1,276	1158	4.68	164	1215	4.87
Hispanic	204	1235	4.62	3,233	957	4.18	324	1090	4.62
Native American	65	1256	4.62	899	862	4.19	102	1020	4.60
Pacific Islander	4	1266	4.91	41	1060	4.28	5	1186	4.54
White	2,360	1316	4.75	17,707	1092	4.46	2,081	1166	4.69
Missing	124	1350	4.77	17	870	2.82	1	928	2.82
Multi-racial	-	-	-	1,035	1025	4.33	100	1128	4.64
Total	**3,451**	**1305**	**4.73**	**32,529**	**1025**	**4.40**	**3,442**	**1136**	**4.69**

Source: 2010 Census; 2010-2014 American Community Survey 5-Year Estimates; Census Block to Zip Code Crosswalk; Connect Carolina; Connect Carolina-NCERDC Crosswalk; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018; Expert Report and Production of Richard D. Kahlenberg, January 12, 2018; NCERDC; North Carolina Public High School List; U.S. Department of Education

Note:

[1] Arcidiacono Model 2 Logit regression is estimated on in-state applicants using all Connect Carolina variables for which analogues exist in NCERDC. The variables alum, decision round, class rank type, and athletic preference are therefore excluded. Fee waiver and first generation college status are proxied and included. Each is proxied using Probit regressions of the desired variable on several ACS socioeconomic variables (details in text). The estimated Model 2 regression is used to predict index values for the 98,214 non-foreign NCERDC students in the high school graduation year 2014-15. A predicted admitted class is constructed following Kahlenberg/Arcidiacono's method of summing the predicted admissions probabilities across all students. Note that this Exhibit is based on Arcidiacono Model 2, which does not accurately reflect UNC's admissions process or decisions. This Exhibit does not say anything about what would happen under an actual race-blind admissions plan.

[2] The 2014-15 admissions cycle refers to the class of 2019 per Kahlenberg/Arcidiacono's terminology.

[3] The number of admits in the Status Quo is calculated using North Carolina resident public school students (excluding students who are foreign, are considered to be in "special recruiting categories" according to Arcidiacono, are missing ratings variables, have incomplete applications, or were previously admitted) in the Connect Carolina data. Unlike in KA Simulation 3, applicants with athletic preference are also excluded because there is no analogous indicator in NCERDC data.

[4] Simulation 3 includes no racial/ethnic preferences, no legacy preference, no early decision preference, and no female preference, while adding in Kahlenberg/Arcidiacono's family and neighborhood socioeconomic status-based preferences (the index value is adjusted by 5 for students who have SES_family equal to one and by 5 for students who have SES_neighborhood equal to one). Unlike in the KA simulations, race/ethnicity interacted with missing percentile and missing GPA is also turned off. A predicted admitted class is constructed following Kahlenberg/Arcidiacono's method of summing the predicted admissions probabilities across all students. All counts and average test scores/GPAs are weighted by students' predicted admissions probabilities.

[5] Simulation 3 is run as described in [4]. However, the predicted probabilities of admissions are scaled, per Kahlenberg/Arcidiacono's methodology, until the sum of predicted probabilities is reasonably close to the number of admitted North Carolina resident public school students in the status quo. All counts and average test scores/GPAs are weighted by students' predicted scaled admissions probabilities.

[6] Arcidiacono Model 2 is estimated using the race/ethnicity categories in NCERDC data rather than those in Connect Carolina data, so that the resulting coefficients can be applied to NCERDC data. Therefore, individuals who are both African American and Hispanic in Connect Carolina data are considered African American for the purposes of the estimation because that is how students in NCERDC data are categorized. Because multi-racial is not a race/ethnicity category in Connect Carolina, students identified only as multi-racial in NCERDC are given a value between zero and one for the indicator for each race/ethnicity based on 2010 Census data for those who self-reported as multi-racial: 52.5% African American, 12.7% Asian, 20.7% Hispanic, 1.1% Missing, 11.7% Native American, and 1.3% Pacific Islander.

[7] The average SAT reported is computed based on the highest SAT or converted SAT (based on ACT, using Arcidiacono's method) for all students with non-missing values of SAT or converted SAT.

[8] Following Arcidiacono's method, GPAs below 1 and above 5.41 are set to missing. The average GPA reported is computed for students with non-missing GPAs.

EXHIBIT 7

SAT Score Increase Equivalent to Kahlenberg Bumps [1]
2014-15 Admissions Cycle [2]

Number of Kahlenberg Bumps [3]	Equivalent Increase in SAT Score (Combined Math and Verbal) [4]
1 bump (A, B, or C)	278
2 bumps (A + B, A + C, or B + C)	556
3 (all) bumps (A + B + C)	834

Source: Connect Carolina; Expert Report and Production of Peter S. Arcidiacono, January 17, 2018

Note:

[1] Note that this Exhibit is based on Arcidiacono Model 4, which does not accurately reflect UNC's admissions process or decisions. This Exhibit does not say anything about what would happen under an actual race-blind admissions plan.

[2] The 2014-15 admissions cycle refers to the class of 2019 per Kahlenberg/Arcidiacono's terminology.

[3] See report text for a description of Kahlenberg Bumps A, B, and C. These correspond to what Kahlenberg refers to as preferences for "coming from a family that is socioeconomically disadvantaged," "growing up in a disadvantaged neighborhood," and "attend[ing] schools which are in the most socioeconomically disadvantaged third," respectively. See Kahlenberg Report, pp. 68–70.

[4] Equivalent increases in SAT scores are computed based on coefficients from the regression used in KA Simulations 1–3, run on in-state applicants in the 2014-15 admissions cycle. Arcidacono Model 4 is run with athletic preferences. An equivalent increase in SAT score is calculated assuming that one half of the increase would be in the SAT Math score and the other half would be in the SAT Verbal score.

Number of URM and Non-URM North Carolina Public School Students Eligible for Kahlenberg Bumps

2014-15 Admissions Cycle [1]

Number of Kahlenberg Bumps for Which Student is Eligible [2]	Number of URM Students [3]	Number of Non-URM Students [3]
0 bumps	3,937	21,030
1 bump or more (A, B, C or combination)	35,247	35,979
2 bumps or more (A + B, A + C, B + C, or A + B + C)	21,327	18,349

Source: 2010 Census; 2010-2014 American Community Survey 5-Year Estimates; Connect Carolina; Connect Carolina-NCERDC Crosswalk; Expert Report and Production of Richard D. Kahlenberg, January 12, 2018; NCERDC

Note:

[1] The 2014-15 admissions cycle refers to the class of 2019 per Kahlenberg/Arcidiacono's terminology.

[2] See report text for a description of Kahlenberg Bumps A, B, and C. These correspond to what Kahlenberg refers to as preferences for “coming from a family that is socioeconomically disadvantaged,” “growing up in a disadvantaged neighborhood,” and “attend[ing] schools which are in the most socioeconomically disadvantaged third,” respectively. See Kahlenberg Report, pp. 68–70.

[3] To be consistent with the Kahlenberg/Arcidiacono Reports, under-represented minorities ("URM") include African American and Hispanic applicants (and not Native Americans) and non-URM include Asian and white applicants. This Exhibit excludes Other/NA individuals which include individuals who identified as Native American, Pacific Islander, or had a missing race/ethnicity. A number of students identified only as multi-racial in NCERDC whereas all students in Connect Carolina identified their specific race(s). Based on 2010 Census data, 73.2% of students self-reporting as multi-racial are considered as URM, and are included in the number of URM students; 12.7% of students self-reporting as multi-racial are considered as non-URM, and are included in number of non-URM students.

EXHIBIT 9

KA Simulation 5: Top 4.5 Percent Model, with Average SAT Score Calculated Correctly [1]

2014-15 Admissions Cycle [2]

	Status Quo: Actual UNC Admitted Class [3]		Kahlenberg Report Results [4]		Kahlenberg Report Results, but Without Adm. Prob. Weighting on Test Scores [5]
Race/Ethnicity	Total Admits	Avg. SAT Score	Total Admits	Avg. SAT Score	Avg. SAT Score
African American	383 (9%)	1195	491 (13%)	1216	1098
Asian	488 (11%)	1354	423 (11%)	1359	1294
Hispanic	241 (5%)	1238	237 (6%)	1272	1189
Native American	74 (2%)	1261	49 (1%)	1298	1214
Pacific Islander	7 (0%)	1284	5 (0%)	1270	1239
White	3,064 (69%)	1320	2,419 (65%)	1323	1271
Missing	170 (4%)	1358	117 (3%)	1352	1310
Total	**4,427 (100%)**	**1309**	**3,741 (100%)**	**1320**	**1246**

Source: Connect Carolina; Connect Carolina-NCERDC Crosswalk; Expert Report and Production of Richard D. Kahlenberg, January 12, 2018; NCERDC
Note:

[1] Note that this Exhibit is based on Arcidiacono Model 4, which does not accurately reflect UNC's admissions process or decisions. This Exhibit does not say anything about what would happen under an actual race-blind admissions plan.

[2] The 2014-15 admissions cycle refers to the class of 2019 per Kahlenberg/Arcidiacono's terminology.

[3] The Status Quo is reported in the Kahlenberg Report Table C.3. Average SAT scores by race/ethnicity are not reported by Kahlenberg, but are reported here based on the underlying code.

[4] The results of Simulation 5 are reported in the Kahlenberg Report Table C.3. Average SAT scores by race/ethnicity are not reported by Kahlenberg, but are reported here based on the underlying code.

[5] In the Kahlenberg Report Table C.3, SAT scores are weighted by the admitted students' predicted admissions probabilities. However, per the Kahlenberg Top Plan, once a student is identified as eligible for admissions, he or she is admitted. Therefore, admitted students' SAT scores should not be weighted by the predicted admissions probabilities, as all admissions probabilities for admitted students are equal to 1. The average SAT scores here are presented by weighting all admitted students equally. Also, Kahlenberg/Arcidiacono mistakenly exclude students' SAT scores from the average calculations when the student is missing GPA. This is corrected here. Only students with missing SAT scores are excluded from the calculation of average SAT scores.

Appendix A

Appendix A

Materials Relied Upon

Academic Articles

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